

A REVISION OF THE GENUS SPATHIUS IN AMERICA
NORTH OF MEXICO (HYMENOPTERA, BRACONIDAE)*

By

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This study is intended as a contribution to the series of systematic studies of the subfamily Doryctinae for the Nearctic Region, initiated by Marsh (1965).

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INTRODUCTION

Spathius is a cosmopolitan genus of Braconidae with over 300 described forms which, with few exceptions, are ectoparasites of wood-boring coleopterous larvae, predominantly Scolytidae. A relatively recent revision of the Old World species exists (Nixon, 1943). For the Nearctic species, the only work to date consists of a few isolated and vague descriptions, and Ashmead's (1893) key to the species (including several newly described ones). This has proved unusable because of several errors and inconsistencies. The 16 described Nearctic species (Muesebeck *et al.*, 1951) have been so poorly understood that identification has been impossible except by comparison with the types.

This revision recognizes 21 species of North American Spathius, of which 11 are described as new. The types of all previously described species have been examined and new descriptions prepared for all valid species. Of the more than 2500 specimens seen, a large proportion represent reared series. In addition to providing host data, these series have permitted positive sex associations and made it possible to more accurately assess intraspecific variation.

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TERMINOLOGY AND SPECIFIC CHARACTERS

The descriptive vocabulary used in the species descriptions is taken largely from Nixon's (1943) revision of the Old World Spathiinae and Marsh's (1965) review of the Nearctic Doryctinae. However, to minimize confusion, diagrams have been prepared illustrating various body parts and showing the points between which measurements have been made.

Measurements were made with the aid of an ocular micrometer, the majority at a magnification of 72x on a Leitz stereoscopic microscope. All quantitative measurements, with the exception of body and wing length, are presented in the form of proportions. Where possible, measurements were taken on at least ten individuals of each sex, selected to represent as wide a geographic range as possible. Care was taken to be as accurate as possible, but it is recognized that differences in viewing angle as well as personal idiosyncrasies of technique will give slightly different results for different workers.

In this regard it is important to adjust the specimen so that the end points of the linear measurement fall in the same focal plane. Drawings of wing venation and male genitalia were prepared from material mounted on slides and projected with a Bio-Scope. All other drawings were made on squared paper with the aid of a squared ocular disc.

HEAD.- In *Spathius*, as in most Doryctinae, the head is slightly broader than long, with the temples broad behind the eyes, giving the head a subcubical shape. The occiput is always completely margined by the occipital carina; in the Nearctic species, this carina is never fused with the hypostomal carina, although such fusion occurs in several species groups of Old World *Spathius*, and is usually correlated with a narrowing of the temples. (One Old World species, *Spathius aristaeus* Nixon, differs from all other *Spathius* in the lack of a completely margined occiput.)

The antennae of *Spathius* are usually slender, filiform, and as long as or longer than the body; the number of segments is highly variable within a species (for example, 25-36 segments in *S. trifasciatus*), and the right and left antennae may differ in number of segments on the same individual. In the descriptions, number of flagellomeres is used and refers to number of flagellar segments only, excluding the scape and pedicel. In the *brachyurus* group, the flagellomeres are characteristically shortened and subcubical, each with a corona of distinctly longer setae at its apex; also the number of flagellar segments in this group is the lowest for any *Spathius*. On close examination under high power, the eyes of most if not all *Spathius* have minute hairs between the facets, these being most obvious in members of the *brachyurus* group.

The maxillary palpus of *Spathius* is six-segmented and typically somewhat elongate, reaching nearly to the mesocoxal cavities. However, the *brachyurus* group exhibits a tendency toward reduction in palpal size, reaching an extreme in *S. brevipalpus*, sp. n. The mandibles are always bidentate, their bases striate ventrally, and are of little taxonomic value.

Head sculpture*, an important species character, is described with reference to four major regions as follows (Figs. 1, 2):

Face: area between clypeus and antennal insertions; it is almost always transversely strigose-granular in Nearctic *Spathius* and of little taxonomic value.

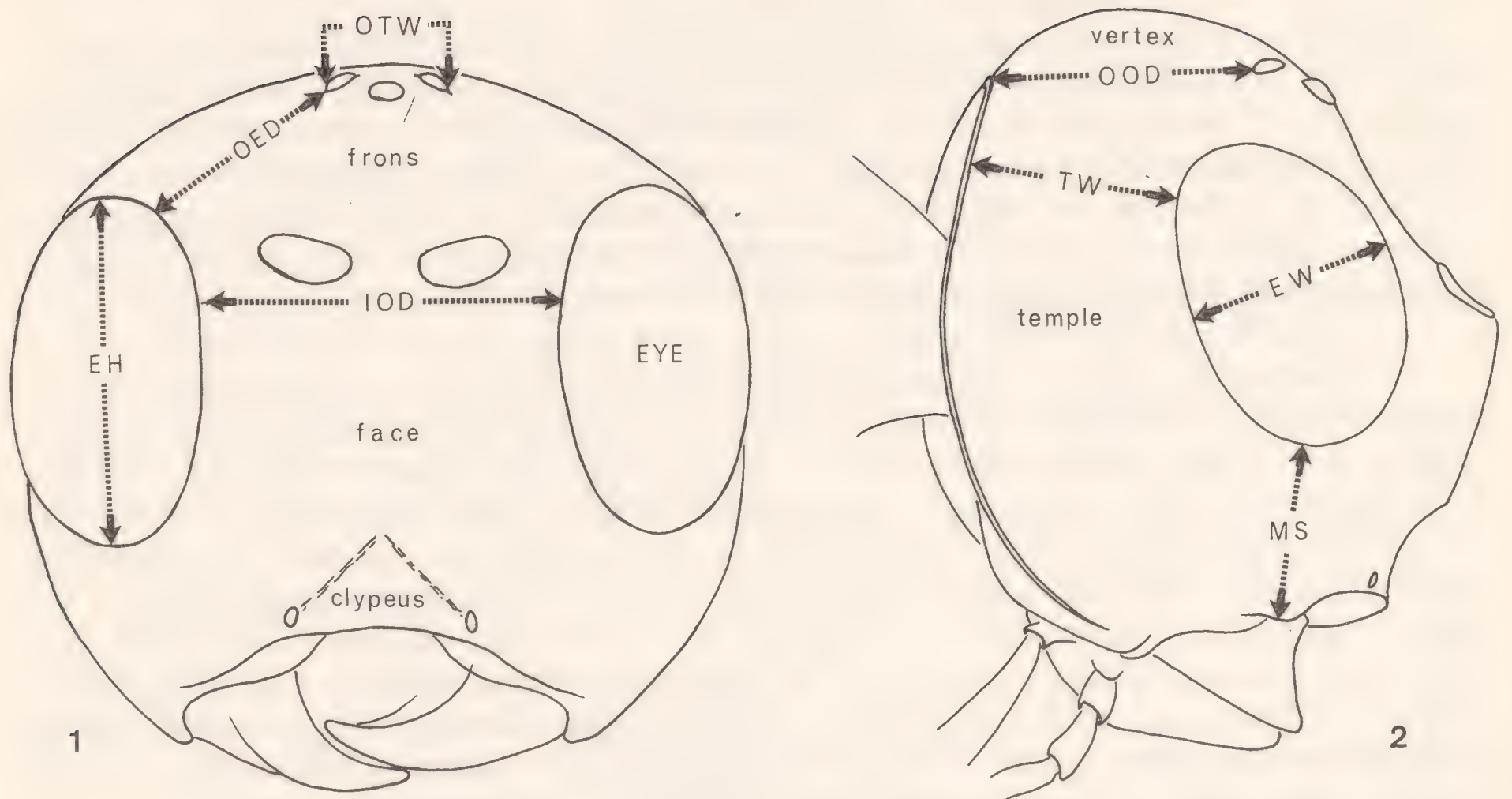
Frons: area between antennal insertions and median ocellus; it has typically transverse striation of varying intensity, but is rugose or smooth in some species.

Vertex: dorsal region of head between lateral ocelli and occipital carina.

Presence or absence of sculpture here is an important species character; when present it usually occurs as transverse striations of varying intensity.

Temples: area between eyes and occipital carina; some Nearctic *Spathius*, in contrast to most doryctines, exhibit fairly prominent sculpturing here.

* Midway in this study Eady (1968) published a paper illustrating types of microsculpture in the Hymenoptera and the terminology used to describe them. In general my interpretations are in agreement, and his paper should be consulted for clarification of any descriptive terminology concerning sculpture.



Figures 1 and 2. Head of *Spathius floridanus* Ashmead, frontal and lateral views respectively; explanations of measurements and terminology given in text.

Additional very useful characters are size and position of the eyes and ocelli; following are measurements and abbreviations for expressing these features (Figs. 1, 2):

Eye Height (EH): maximum height (or length) of eye measured in lateral view.

Eye Width (EW): maximum width of eye measured in lateral view.

Malar Space (MS): least distance between lower eye margin and mandible base.

Ocello-eye Distance (OED): least distance between a lateral ocellus and eye margin on same side.

Ocello-occiput Distance (OOD): least distance between occipital carina and a line tangent to posterior margins of lateral ocelli.

Ocellar Triangle Width (OTW): maximum distance between (and including) lateral ocelli.

Temple Width (TW): least distance between occipital carina and posterior dorsal margin of eye.

Interocular Distance (IOD): least width of face along a line just below antennal insertions.

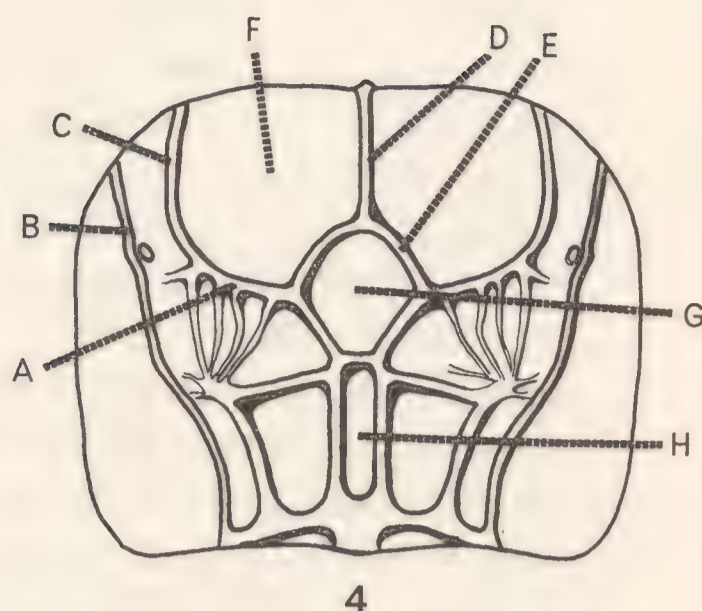
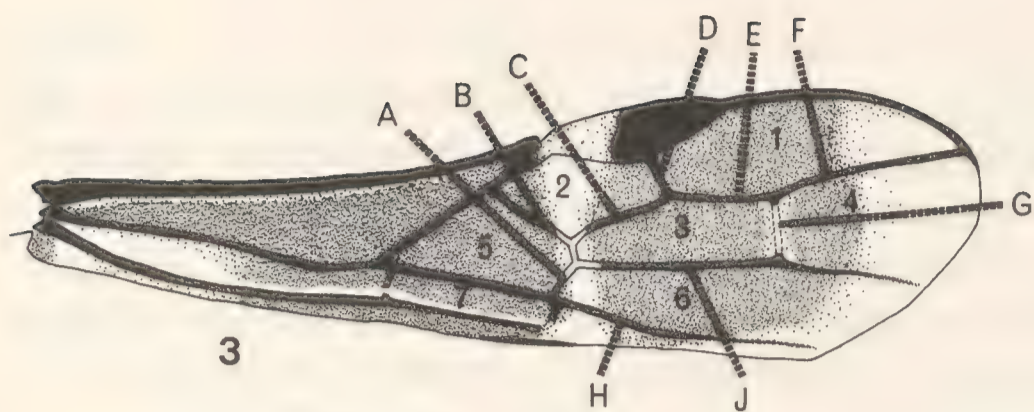


Figure 3. Fore wing of *S. floridanus*, ♀. Veins: A, recurrens; B, first abscissa of cubitus; C, first intercubitus; D, E and F, first, second and third abscissae of radius; G, second intercubitus; H, subdiscoideus; J, second abscissa of cubitus. Cells: 1, radial; 2, 3 and 4, cubital; 5 and 6, discoidal; 7, first brachial cell.

Figure 4. Propodeum of *Spathius marshi*, sp. n. A, costula; B, lateral carina; C, dorsal carina; D, basal carina; E, fork of basal carina; F, dorsal area; G, areola; H, area petiolaris.

THORAX. - The term thorax here means the morphological thorax plus propodeum. Thoracic shape is of some value in species diagnoses. Occasionally a specimen is found which at first appears to be radically different because the thorax is strongly dorsoventrally compressed. These are presumably due to unusually shallow pupation spaces and one must take care not to be misled by them. However, *S. calligaster*, sp. n. is normally strongly flattened (Fig. 17). I have found greatly flattened individuals of three additional species; these are difficult to key because they are so distorted, but otherwise possess the typical species characters. Occasionally, the form and development of the prothoracic "lateral area" (see Nixon, p. 179) is of specific value. However, the position of the "pronotal keel," which Nixon found useful in the Old World *Spathius*, is of little value in the Nearctic forms, being always at least partially fused medially with the posterior margin of the pronotum.

Taxonomically important characters of the thorax include:

1. Mesonotal declivity as viewed from the side.
2. The degree to which the notauli are depressed in a furrow posteriorly.
3. Sternaulus* sculpture and form (for example, compare Figs. 5, 14 and 22).

The mesopleural disc immediately above shows considerable sculptural variation in the Nearctic species, from smooth to strigose to granular to rugose.

4. The prepectal carina crosses the mesosternum anteriorly behind the fore coxae and continues dorsad onto the mesopleuron, forming the posterior border of a roughly pentagonal prepectal area above the fore coxae at the anterior end of the sternaulus (Figs. 5, 14, 17 and 22). The prepectal carina is "incomplete" (Fig. 17) if its expression is obscured at any point along the border of the prepectal area. Sculpture of the prepectal area is also of some specific importance.

* Equals mesopleural furrow in Nixon's and Marsh's terminology.

5. The number and form of the transverse carinae of the scutellar furrow is of specific value in some cases. The scutellar disc is usually granular, but may be rugose or smooth in certain species; the degree to which it is flattened or conically raised (see Fig. 14) is also important.
6. Major carinae of the propodeum, and areas enclosed by them, are indicated in Figure 4. In the European Spathius exarator, relative lengths and degree of development of propodeal carinae have been shown to be highly variable (Beyr, 1961); the same appears true for Nearctic species. However, the shape and sculpture of the enclosed areas, and within broad limits the angle of carinae intersection, appear somewhat more reliable. Also, the posteriolateral angles are occasionally produced to form distinct tubercles or projections which are very useful taxonomically.

LEGS. - The fore tibia bears a row of 10 to 50 stout spines on its anterior edge. Their number and arrangement, while often difficult to see, is of specific value within a broad range, as is a row of as many as 9 spines at the apex of the fore tibia. The outer apical lobe of the hind tibia (see Figs. 18 and 23) usually also bears a row of spines whose number is of specific importance. Frequently, relative lengths of the hind tarsal segments are also useful; however, leg shape is rarely of value except in the males of the trifasciatus group which have the femora considerably swollen (Fig. 15). Presence or absence of a dentiform projection ventrally at the base of the hind coxae may also be of some specific value, although it is variously developed in nearly all the Nearctic forms. The tibiae are banded in the majority of Nearctic Spathius; in some species, however, the bands may be poorly demarcated, the tibiae appearing unicolorous.

WINGS. - Terminology used in reference to Spathius fore wing venation is shown in Figure 3. Presence or absence of infumated wing bands is important, as are relative lengths of first intercubitus and second abscissa of the radius. In addition, the subdiscoideal position, interstitial or not, and differences in cell shapes and proportions, while subtle, are often useful. Males of one Nearctic species, S. stigmatus, sp. n., have a well developed stigma present in the hind wing (Fig. 13); it is of interest that such stigmal development also occurs in several Old World species. Otherwise, hind wings of Nearctic species are quite uniform, but variation occurs in the position of the postnervellus, which if displaced basally divides the mediella into three abscissae; however, this character is highly intraspecifically variable and not reliable.

ABDOMEN. - Numbering of the abdominal segments begins with the first apparent segment (petiole) rather than with the first true morphological segment (propodeum) which for descriptive purposes is here included with the thorax. As used here, the abdomen consists of two main parts, petiole and gaster (segments 2-7). In lateral view, the petiole may be arched (Fig. 5) or nearly straight (Fig. 22); length, while often showing considerable variation, is sometimes of specific importance. Measurement of the petiole is made in dorsal view and expressed as a proportion of the maximum dorsal length of the following segment [tergite (2-3)]. Also, length of the petiolar sternite in relation to total petiole length is of specific value in certain instances.

The first two gastral tergites are not separated dorsally, and I follow Nixon and Marsh in referring to this segment as tergite (2-3). Presence or absence of a thickened lateral margin just below the spiracles on tergite (2-3) is a useful specific character for females; males uniformly possess this thickened lateral margin, which may often be present on subsequent tergites.

Although petiolar sculpture is of little value (see Beyr, 1961), consisting mostly of irregular longitudinal striation, sculpture of the gaster is an impor-

tant character. Its form and expression may, however, vary somewhat both within and between the sexes of a given species. Usually sculpture, when present, is confined to the basal portion of tergite (2-3) but in *S. calligaster*, sp. n. much of the gaster is coarsely granular. If sculpture occurs on tergites 4 to 7, it is usually in the form of fine punctulation. The epipleura of the tergites, defined as that part of the tergites ventral to the spiracles and covering the lateral face of the abdomen, may also show fine punctate or shagreened sculpture in some species.

Male genitalia of all known species were examined in the course of this study, but on the whole are rather uniform and few useful characters were noted. Differences in number, arrangement and relative lengths of the paramere setae, size and shape of basal ring, and relative length of aedeagal apodemes may prove to be of use in distinguishing males of some species.

SIZE, COLOR AND VESTITURE. - Because it is not influenced by head position and abdominal distension, fore wing length (FWL), measured from the free edge of the tegula to the apex of the wing, is given in the descriptions as a more reliable indication of size than body length (BL); for the same reason, ovipositor sheath length (OSL)* is expressed as a proportion of wing rather than of body or abdomen length.

For the most part, the chief diagnostic value of color lies in the arrangements and patterns produced, such as the banded hind tibiae, so that attempts to use exact color terminology would only make the descriptions more cumbersome while adding little to their usefulness. Considerable intraspecific variation in body color may occur in many species and is specifically noted in those cases.

Although Nixon made extensive use of vestiture characters, especially relative length of dorsal hairs of the hind tibia, little variation of this nature was found to occur in the Nearctic forms.

GENERAL REMARKS. - Many species of *Spathius* described by Ashmead (1893) were based on specimens reared by A. D. Hopkins. The previous year Hopkins (1892) had published a list of his bred parasites in *Insect Life*, using Ashmead's manuscript names. Hopkins' original manuscript for this paper is on file in the U. S. National Museum; it is identical to the published version except that Hopkins' specimen label numbers are listed next to the species names. Association of specimens and numbers has been of crucial importance in this revision since most of Hopkins' specimens (and consequently Ashmead's types) have no labels other than this number, and in some cases several specimens have the same number. Hopkins' manuscript has thus often been the sole means for determining which specimens Ashmead had before him and for associating specimens with host and rearing data. Associated insects, host trees and other data (locality, date of emergence, etc.) are recorded on cards filed by number in the U. S. National Museum. I have made extensive use of this Hopkins card file as well, and have listed the Hopkins numbers in the species discussions where they were sources of host or other information.

Much of the confusion so long surrounding the identity of the described Nearctic *Spathius* species can be traced to Ashmead's (1893) descriptions and key. The major characters he used were body color, wing infumation pattern and ovipositor length, the first two of which have proved totally inadequate. Furthermore, his often hurried work resulted in considerable carelessness and inconsistency. For example, his key couplet to *S. unifasciatus*

* Ovipositor sheath length was measured rather than ovipositor length per se because the apparent ovipositor length depends greatly upon angle of extrusion.

(= trifasciatus Riley) states "ovipositor twice the length of abdomen", a fact contradicted by both his own formal description of the species and by examination of the type. At another point he states that S. laflammei Provancher has an ovipositor twice its body length; even if Ashmead had not seen the type, Provancher's description clearly states "Tarriere presque aussi longue que le corps" (Provancher, 1880, p. 164).

Genus SPATHIUS Nees

Spathius Nees, 1818, Nova Acta Acad. Caesar. Leop. Carol. 9: 301.

Type: Ichneumon exarator Linnaeus. Monobasic.

Stenophasmus Smith, 1859, J. Linn. Soc. Lond. 3: 169.

Type: Stenophasmus ruficeps Smith. Monobasic.

Euspathius Foerster, 1862, Verh. naturh. Ver. preuss. Rheinl. 19: 236.

Emendation of Spathius.

Rhacospathius Cameron, 1905, Spolia zeylan. 3: 86. Type: Rhacospathius striolatus Cameron. Monobasic.

Head subcubical, variously sculptured; occiput margined; ocellar triangle with base usually longer than sides, rarely equilateral; first flagellar segment at least as long as second, usually slightly longer; flagellum with 16 or more segments; fore and mid tibiae with 10-55 spines along anterior edge and a row of 4-11 at apex; outer apical lobe of hind tibia with a row of 0-9 spines; fore wing with 3 cubital cells, the recurrent vein entering the second cubital cell; subdiscoideus leaving first brachial cell above middle, occasionally interstitial with discoideus; submediellan cell present in hind wing but short, second abscissa of mediella always longer than first; hind wing of males occasionally with stigma-like thickening at junction of costella, basella and radiella veins; first abdominal tergite lengthened, petiolate, usually abruptly dilated at apex; gaster smooth or variously sculptured, sculpture when present often confined to tergite (2-3); tergite 7 with area of close longitudinal striation on basal half, this area often hidden by overlapping margin of previous tergite; epipleura of tergite (2-3) always fused in females, but separated in males*; ovipositor variable in length but always at least half as long as gaster; male genitalia as in Figure 20.

Discussion. - The essential characters by which Spathius may be distinguished from all other Doryctinae are: (1) abdomen petiolate, the first abdominal tergite lengthened and usually abruptly dilated at apex; (2) fore wing with three cubital cells, the recurrent vein always received into the second cubital cell; and (3) the subdiscoideus always originating above middle of first brachial cell.

The condition of the epipleura of tergite (2-3) - fused in females and divided in males - is somewhat unique to Spathius. Separation of the epipleura of tergite (2-3) in both sexes is characteristic of most other doryctine genera (about 90%, Marsh, in litt.). The adaptive significance of fusion versus division is not understood.

Additionally, the position and form of the stigma in the male hind wing of some species is unusual, being a thickening at the junction of the costella, radiella and basella veins (Fig. 13; see also S. erigone Nixon, 1943, p. 290).

* Nixon (1943) apparently overlooked the separated epipleura of the males, stating in his generic description that the epipleura are always fused.

In most doryctines having stigmal development in the male hind wing (e. g. Acrophasmus, Heterospilus) the stigma is a large thickening along the costal margin and the other veins are greatly reduced or absent (see figures in Marsh, 1965).

Until quite recently, Spathius and its relatives were recognized as a separate subfamily, the Spathiinae. Both Nixon (1943) and Marsh (1965) have adequately reviewed the history of the classification of Spathius and related genera, particularly those of the stephaniscine complex. (For a review of the classification and phylogeny of the entire Braconidae see Tobias, 1967.) In his comprehensive review of the Nearctic Doryctinae, Marsh (1965) has included Spathius and all of the stephaniscine complex in his redefined Doryctinae, based upon "similarities among these groups in wing venation, fore tibial spines, male genitalia and general morphology". Tobias (1967) concurs, but regards the group as a supertribe, Doryctina, in his subfamily Braconinae.

As the situation now stands, I am in general agreement with Marsh and Tobias. However, having seen a considerable sample of unnamed Neotropical doryctines, a large proportion having the typical "Spathius" facies, I am convinced that the present system still leaves much to be desired. It is apparent that the spathiines have radiated extensively in the Neotropics, the diversity being perhaps greater than that found by Nixon in the Old World Malayan Archipelago, which he regarded as the center of distribution for the genus. At present, there are some 7 species of Spathius described from the Neotropics (not including several from the West Indies which are discussed by Matthews and Marsh, 1969). While much like typical Spathius, all differ in having the recurrent vein received by the first cubital cell and the subdiscoideus arising below the middle of the brachial cell; this venation is widespread among Neotropical "Spathius". In addition, I have found at least three other distinct venational types, including the typical form. These anomalies can be dealt with only after further study. For these reasons, conclusions on generic, tribal and subfamily limits in this complex must await redefinition of the Doryctinae based on more thorough knowledge of the world fauna, as classifications based primarily upon north temperate faunas are proving increasingly inadequate. For the same reasons, I prefer to defer the question of the generic affinities of Spathius. Both Nixon and Marsh regard Rhaconotus Ruthe as the closest relative of Spathius. However, as Nixon pointed out, the blister-like swelling on the front and middle femora and the unfused epipleurites of tergite (2-3) characteristic of the Rhaconotus-Platyspathius complex are not at all typical of Spathius.

Paleontology. - Four spathiine fossil species from the Tertiary have been described - three from Rott by Statz (1936, 1938) and a fourth, Scudder's Ichneumon petrinus, noted by Brues (1910). Through the courtesy of Dr. Charles L. Hogue, Senior Curator of Entomology at the Los Angeles County Museum, I have been able to study Statz's Spathius types. The wings of S. pedicularis are hyaline and the specimen is beautifully preserved. The fossils of S. macroradialis and S. longicornis are less well preserved.

Of these three, only S. pedicularis is a true spathiine, its venation agreeing with that noted earlier for the majority of Neotropical species, viz., the recurrent vein entering the first cubital cell and the subdiscoideus arising below the middle of the brachial cell. S. longicornis, although probably a doryctine, exhibits the wrong petiole shape and venation for Spathius. S. macroradialis appears to belong to the Opiinae, having the typical venation and petiole shape of that group.

Scudder's (1890, pl. 5, fig. 14) figure lacks sufficient detail for precise placement, and I have not seen his specimen. Judging from his figure, the petiole of Ichneumon petrinus does not appear to have the typical spathiine shape. Brues is probably correct, however, in assigning it to the Braconidae.

In over 1,000 blocks of Tertiary and Cretaceous amber currently under study, no spathiines have been found (L. Masner, in litt.).

Distribution. - Representatives of Spathius are described from every zoogeographic region. According to Nixon (1943) the greatest concentration of species occurs in the Malay Archipelago, the group apparently originating in that region. However, as noted above, there also appears to have been an extensive spathiine radiation in the Neotropical Region. Nixon recognized only 6 species from the Palearctic Region, but was handicapped by not having access to many of the types; more recently, Fischer (1966) has given a key to 12 species occurring in Europe (one new) and at least two others have also been described from the Palearctic Region since 1943. For the Nearctic Region I here recognize 21 species. No Holarctic species are currently known. I have examined the scanty Palearctic material available in the U. S. National Museum, and although the possibility of holarctic distributions cannot be totally ruled out at this time, none of the North American species will successfully run through Nixon's or Fischer's keys.

Because of their parasitism of wood-boring beetles, the chance of accidental introductions is ever present. Indeed, at least 4 foreign species (based on specimens in the U. S. National Museum and Canadian National Collection) have been intercepted in infested wood items at American ports of entry. However, none appear to have become established. One of these, Spathius vulnificus Wilkinson, a parasite of bostrichid beetles from India, has been intercepted at no fewer than 4 different ports. Another, Spathius exarator Linnaeus, a parasite of anobiids from Europe, has been frequently recovered from imported items.

EVOLUTIONARY TRENDS

Although in a few cases the Nearctic species could be construed to fit certain of Nixon's (1943) groups of Old World Spathius (particularly the exarator, elaboratus, fasciatus and labdacus groups), none possess the exact combination of characteristics of these groups; where individual North American species show resemblance to Old World species, this has usually been mentioned in the species discussions. For purposes of showing relationships, however, I have divided the Nearctic Spathius into the following species groups, which I feel represent more or less natural groupings:

1. The brachyurus group: brachyurus Ashmead, brevipalpus, sp. n., marshi, sp. n. and stigmatus, sp. n.
2. The calligaster group: calligaster, sp. n.
3. The longipetiolatus group: longipetiolatus Ashmead, elegans, sp. n. and evansi, sp. n.
4. The sequoiae group: sequoiae Ashmead, canadensis Ashmead and aphenges, sp. n.
5. The pallidus group: pallidus Ashmead, parvulus, sp. n. impus, sp. n. and comes, sp. n.
6. The laflammei group: laflammei Provancher and benefactor, sp. n.
7. The trifasciatus group: trifasciatus Ashmead and brunneus Ashmead.
8. The simillimus group: simillimus Ashmead and floridanus Ashmead.

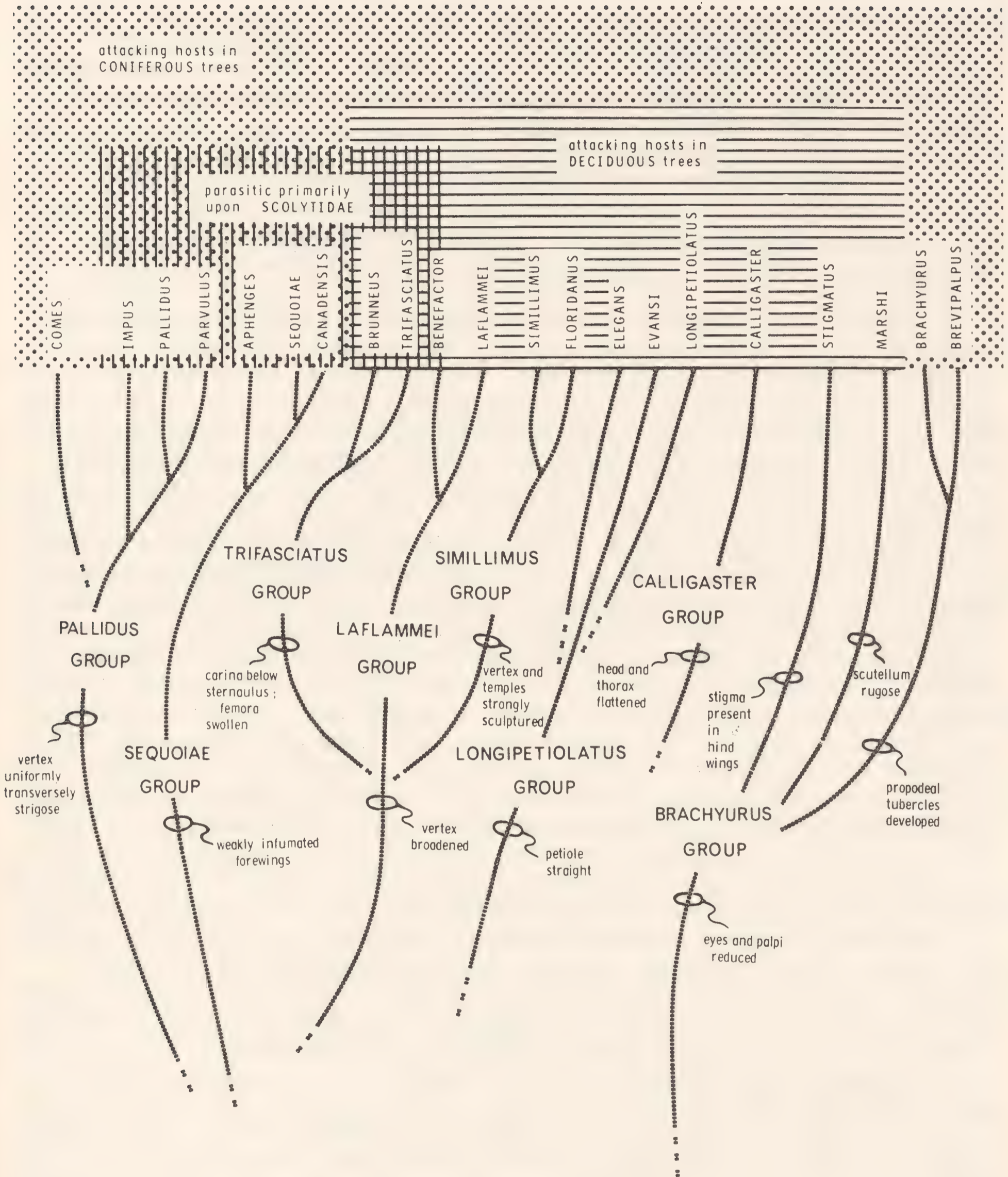


Figure 4A. Possible relationships within the Nearctic Spathius. Further explanation in text.

Figure 4A depicts my concept of the relationships among the North American species of Spathius, based upon both morphological and biological characters. Two main lines of descent are apparent, one being that taken by the brachyurus group and the other including the remaining 17 species, within which several distinct evolutionary trends can be recognized.

Members of the brachyurus group are united by the combination of the reduced maxillary palpi, reduced and conspicuously hairy eyes, broad temples, long malar spaces, first intercubitus much shorter than second abscissa of radius, and reduced antennae, the flagellomeres approaching a subcubical shape. The group is clearly specialized, as evidenced by the tendencies toward reduction in maxillary palpi, number of flagellomeres and eye size. The trend toward reduction of the maxillary palpi reaches its extreme in S. brevipalpus, which has apparently completely lost one segment in addition to having the others highly reduced. The brachyurus group does not show clear affinities to any Old World species nor to the remaining Nearctic species. Perhaps it should be given subgeneric or generic rank; however, I prefer to defer such designation until such time as the doryctine fauna is more completely known and generic limits better defined.

Within the brachyurus group, S. brachyurus is apparently the least specialized, having the most nearly normal eyes and the greatest number of flagellomeres; S. brevipalpus seems closely related to brachyurus, both possessing the unique tubercles at the posterior-dorsal-lateral angles of the propodeum and nearly identical body sculpture. Additionally, both are parasites of beetles in pines. The remaining members, S. marshi and S. stigmatus, are both parasites of beetles in deciduous trees, but apparently represent separate evolutionary trends. Of the two, stigmatus is probably the more specialized, having the fewest number of flagellomeres (16-20) of any Nearctic species. Presence of a stigma in the male hind wing, while unique among the Nearctic species, is probably a convergent character, since similar stigma-like thickenings occur sporadically in several Old World species; this character's adaptive significance is not understood. The unique combination of characters possessed by S. marshi, particularly the form of the sternaulus (Fig. 5) and the rugose scutellum, apparently have no parallel in any described Spathius; additionally, the wings are totally hyaline, somewhat atypical for the genus.

The calligaster group is represented only by Spathius calligaster, an isolated species of uncertain affinities; it is characterized by the strongly flattened head and thorax (Fig. 17), coarsely granular sculpture on all but the apical margins of tergites (2-3), 4 and sometimes 5, absence of spines on the outer apical lobes of the hind tibiae, strongly thickened lateral margin of tergite (2-3) and the typically interstitial subdiscoideus vein. The flattened body is convergent with species of Nixon's labdacus group but other characters do not correlate. Biologically it is unique in attacking eucnemid beetles.

The longipetiolatus group includes the largest of the Nearctic species. Except for isolated rearing records from various hardwoods and a single host record (for elegans attacking an anobiid), nothing is known of the biology of this group. The three included species are not closely related, and the group's affinities are uncertain although some characters are shared with the Palearctic exarator group. Available evidence suggests that the longipetiolatus group may be most generalized of the Nearctic groups and probably closest to the ancestral spathiine stock, its members being characterized by relatively large size, long ovipositors (the ♀ longipetiolatus is unknown), and elongate, straight petioles (Fig. 22). The antennae of evansi have the most flagellomeres of any Nearctic species (35-48); it is also one of the most widely distributed of the

of the Nearctic species, occurring from the Rockies eastward.

Members of the laflammei, simillimus and trifasciatus groups appear to be derived from the same basic stock, but have split into three distinct evolutionary lines. All three groups share the relatively wide vertex, a well-developed row of 3-10 spines on the outer apical lobe of the hind tibia, and strongly banded fore wings; additionally, they all attack beetles in deciduous trees. A dominant evolutionary trend in the complex seems to be the acquisition of a relatively wide vertex and broad temples; a general increase in body robustness is also apparent.

The laflammei group seems to represent the basic stock of the complex, with S. benefactor apparently the most generalized member, having the narrowest vertex. It is sometimes hard to distinguish this species from members of the pallidus and sequoiae groups. Both benefactor and laflammei attack weevils and bark beetles in deciduous trees, benefactor being commonly reared from elm.

The trifasciatus group has acquired at least two unique features: the presence of a strong longitudinal carina beneath the sternaulus (Fig. 14) and strongly swollen femora in the males (Fig. 15). The two included species attack closely related species of scolytids, trifasciatus being commonly reared from Scolytus quadrispinosus in hickory and brunneus from S. muticus in hackberry.

As the third group of this complex, the simillimus group is characterized by the very strong uniformly granular-strigose sculpture of the vertex and temples and the usually rugose or wrinkled scutellar furrow carinae. Its two members have become specialized upon a different host assemblage, attacking either cerambycid or buprestid larvae almost exclusively.

All of the members of the sequoiae and pallidus groups have become adapted to beetles attacking conifers, a major ecological shift, and within each group certain secondary trends can also be recognized; the species comprising both groups include some of the smallest and taxonomically most difficult members of the Nearctic fauna. The sequoiae group is characterized by weakly infumated, indistinctly banded fore wings and a nearly smooth to delicately strigose vertex. Of the three included species, S. aphenges is probably the most advanced, with the shortest ovipositor of any Nearctic species (except parvulus), reduced head sculpture, and specialization upon beetles attacking pine cones. S. canadensis and S. sequoiae appear to be quite closely related and possibly subspecies, but more data are needed to resolve that problem; both attack a similar host complex, sequoiae being western in distribution and canadensis being primarily eastern, the ranges overlapping in some parts of western North America.

Members of the pallidus group have the vertex uniformly transversely strigose and have strongly banded fore wings. The three most closely related members - impus, pallidus and parvulus - have relatively narrow vertex and temples, and are parasitic upon scolytids in conifers. S. impus is apparently restricted to Phloeosinus beetles attacking members of the Taxodiaceae and Cupressaceae. S. parvulus and S. pallidus are closely related, parvulus being a smaller species with somewhat reduced mesopleural and vertex sculpture, and a shorter ovipositor; both attack scolytids and curculionids in various species of pine. The remaining species, S. comes, is only tentatively included here; it has broader temples, a longer ovipositor than the others, and has become specialized on buprestids.

The origins and affinities of the Nearctic Spathius fauna are somewhat obscure. The possibility exists that it could have been derived from some as yet unknown Neotropical stock. However, based on material I have seen there appears to be a distinct separation between the faunas of North America

and Mexico, and no species are known from the arid parts of the southwestern United States. This gap may be an artifact of the efforts of collectors, but probably represents a real situation, as the genus is primarily adapted to forested regions. As noted earlier, Neotropical species have certain major differences, especially in wing venation, so that Neotropical origin of the North American species appears unlikely. Instead, the Nearctic Spathius were probably derived from Palearctic elements and the possibility exists that more than one invasion may have occurred.

BIOLOGY

Several isolated studies of the biology of various Spathius species around the world have been made, but the information is too fragmentary for a full-scale comparative consideration of this subject at the present time. For a summary of biological information on Old World species, reference may be made to Nixon (1943). One paper overlooked by Nixon is that of Russo (1938) which includes a discussion of the biology of Spathius rubidus Rossi. Since 1943, two excellent papers by Lyngnes (1955, 1960) on the European Spathius exarator Linnaeus have appeared, which include descriptions of mating and oviposition behavior, larval development, and functional morphology of the female reproductive system; additional more recent papers include a study of the Philippine S. fuscipennis Ashmead (Ishii, 1953) and a brief comparative treatment of internal ovarian morphology of a Japanese species (Iwata, 1959).

For the Nearctic species, published biological information (other than host records) exists only for S. benefactor, sp. n., reported under the name S. canadensis Ashmead; under the description in this paper, work on the life history of this species (Kaston, 1937, 1939; Robert, 1951 a&b, 1960) is summarized briefly. In the following paragraphs, mention will be made of only a few salient general features regarding the biology of Nearctic Spathius.

Host specificity and larval food habits. As ectoparasites upon the larvae of wood-boring beetles, larvae of the genus Spathius are essentially separated in definition from general predators only by consumption of a single host rather than several (Doutt, 1959). In laboratory studies, species have been shown to satisfactorily accept novel hosts, even of a different family than forms their usual diet (Ayyar and Narayananaswami, 1940). Furthermore, the numerous hosts recorded for the more thoroughly studied species cause one to additionally suspect that, in conformity with generally noted evolutionary trends among the ectoparasitic Hymenoptera (see Townes, 1962), the main specializations of Spathius are to the site at which the host feeds rather than to taxon of host.

Broadly, the Nearctic species may be divided into two groups: those which attack beetles in coniferous trees and those which attack beetles in deciduous trees (see Fig. 4A)*. Adaptation to elements within each of these broad ecological zones apparently has been achieved on several independent occasions. For example, species from four different stocks (stigmatus, laflammei, trifasciatus and floridanus) are adapted to attacking beetles in hickory; in pine, three Spathius stocks have converged upon the beetles (2 species each in the brachyurus, pallidus

* Only S. floridanus has been reared from both coniferous and deciduous trees, but it exhibits a decided preference for the latter, attacking several different nut trees (hickory, walnut, chestnut and oaks), and the single record of this species from bald cypress requires further confirmation.

and *sequoiae* groups). Within the broad division as to tree types, a second grouping may be made, separating those *Spathius* species which are predominantly parasites of Scolytidae and those attacking non-scolytid borers of several families (see Fig. 4A); however, this division is much less clear-cut. This is not unexpected, since the ovipositing female of each species presumably searches for hosts in a particular ecological niche, there attacking a variety which happen to meet her particular requirements. There are several cases of species attacking both scolytids and curculionids (e.g. *brachyurus*, *sequoiae*, *benefactor*); on the other hand, species attacking the larger borers of the families Cerambycidae and Buprestidae (e.g. *simillimus*, *floridanus*) seem somewhat more restricted to these groups. In general, species with shorter ovipositors tend to attack cambial- and bark-inhabiting scolytids and curculionids, while those with longer ovipositors are parasites of beetles which bore deeper in the tree, but there is not necessarily a correlation between ovipositor length and host taxon. (*Spathius aphenges* is unusual among the Nearctic species in apparently preferentially parasitizing beetles attacking the cones of pine rather than tree trunk and branches.) Another habit which appears to have independently evolved more than once in *Spathius* is that of multiple oviposition in a given host. I have noted evidence for this situation in at least two North American species (*brachyurus*, *floridanus*; see "Biology" for those species), and it is also recorded for *S. vulnificus* Wilkinson (see Nixon, 1943). It will probably turn up quite commonly as the biologies of more *Spathius* species become known.

Within the Nearctic *Spathius*, hosts have been recorded for all but three species (*longipetiolatus*, *evansi* and *marshi*); these are summarized in the accompanying host list. However it must be emphasized that our knowledge of host relations in this genus is still quite incomplete.

Known beetle hosts of Nearctic *Spathius* species. Sources for the records are given in the species descriptions. Asterisks indicate records of association only; definite parasitization of the named host not established.

Anobiidae

<i>Eucrada humeralis</i> Melsheimer	<i>laflammei</i> Provancher
<i>Hadrobregmus</i> sp.	<i>elegans</i> , sp. n.

Buprestidae

<i>Agrilus anxius</i> Gory	<i>simillimus</i> Ashmead
<i>A. fallax</i> Say	<i>brunneus</i> Ashmead
<i>A. bilineatus</i> (Weber)	<i>simillimus</i> Ashmead
<i>Chrysobothris femorata</i> (Olivier)	<i>floridanus</i> Ashmead
<i>C. pusilla</i> Castelnau	<i>comes</i> , sp. n.
<i>Chrysobothris</i> sp.	<i>floridanus</i> Ashmead
<i>Melanophila fulvoguttata</i> (Harris)	<i>comes</i> , sp. n.

Cerambycidae

<i>Callidium aereum</i> Newman	<i>simillimus</i> Ashmead
<i>Leptostylus macula</i> Say	* <i>calligaster</i> , sp. n.
<i>Leptura mutabilis</i> Newman	* <i>calligaster</i> , sp. n.
<i>Neichnea laticornis</i> Say	* <i>stigmatus</i> , sp. n.
<i>Xylotrechus colonus</i> (Fabricius)	<i>floridanus</i> Ashmead

Curculionidae

<i>Magdalis armicollis</i> Say	benefactor, sp. n.
<i>M. barbata</i> Say	benefactor, sp. n.
<i>M. inconspicua</i> Horn.	benefactor, sp. n.
<i>M. olyra</i> Herbst	stigmatus, sp. n.
	laflammei Provancher
	floridanus Ashmead
<i>Pachylobius picivorus</i> (Germar)	*brevipalpus, sp. n.
<i>Pissodes approximatus</i> Hopkins	brachyurus Ashmead
	pallidus Ashmead
<i>P. nemorensis</i> Germar	pallidus Ashmead
<i>P. strobi</i> (Peck)	brachyurus Ashmead
	parvulus, sp. n.
<i>Pissodes</i> sp.	sequoiae Ashmead

Eucnemidae

<i>Melasis pectinicornis</i> Melsheimer.	calligaster, sp. n.
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Scolytidae

<i>Carphoborus intermedius</i> Wood	*sequoiae Ashmead
<i>Conophthorus coniperda</i> (Schwarz).	aphenges, sp. n.
<i>Cryphalus</i> sp.	canadensis Ashmead
<i>Crypturgus atomus</i> LeConte	*canadensis Ashmead
<i>Dendroctonus obesus</i> (Mannerheim)	sequoiae Ashmead
<i>D. frontalis</i> Zimmermann	pallidus Ashmead
<i>D. pseudotsugae</i> Hopkins.	sequoiae Ashmead
<i>Dryocoetes affaber</i> (Mannerheim)	*sequoiae Ashmead
<i>D. autographus</i> (Ratzeburg)	brachyurus Ashmead
	canadensis Ashmead
<i>Hylurgopinus rufipes</i> (Eichhoff)	benefactor, sp. n.
<i>Ips avulsus</i> (Eichhoff)	pallidus Ashmead
<i>I. grandicollis</i> (Eichhoff)	pallidus Ashmead
<i>I. latidens</i> LeConte.	aphenges, sp. n.
<i>I. pini</i> (Say)	canadensis Ashmead
<i>Ips</i> sp.	parvulus, sp. n.
<i>Leperisinus aculeatus</i> (Say)	benefactor, sp. n.
<i>Orthotomicus caelatus</i> (Eichhoff)	canadensis Ashmead
<i>Pityophthorus balsameus</i> Blackman	canadensis Ashmead
<i>P. murrayanae</i> Blackman	*sequoiae Ashmead
<i>Pityophthorus</i> sp.	*aphenges, sp. n.
<i>Phloeosinus canadensis</i> Swaine	impus, sp. n.
<i>P. dentatus</i> (Say)	impus, sp. n.
<i>P. punctatus</i> LeConte	sequoiae Ashmead
<i>P. sequoiae</i> Hopkins	sequoiae Ashmead
<i>Phloeosinus</i> sp.	impus, sp. n.
<i>Phloeotribus puberulus</i> LeConte	aphenges, sp. n.
<i>Polygraphus rufipennis</i> (Kirby)	*sequoiae Ashmead
	canadensis Ashmead

<i>Pseudohylesinus nebulosus</i> (LeConte)	<i>sequoiae</i> Ashmead
<i>Scolytus abietis</i> Blackman	<i>aphenges</i> , sp. n.
<i>S. tsugae</i> Swaine	<i>sequoiae</i> Ashmead
<i>S. multistriatus</i> Marsham	<i>benefactor</i> , sp. n.
<i>S. muticus</i> Say	<i>brunneus</i> Ashmead
<i>S. piceae</i> (Swaine)	* <i>sequoiae</i> Ashmead
	<i>canadensis</i> Ashmead
<i>S. quadrispinosus</i> Say	<i>trifasciatus</i> Riley
<i>S. rugulosus</i> Müller	<i>benefactor</i> , sp. n.
<i>S. ventralis</i> LeConte	<i>sequoiae</i> Ashmead
<i>Scolytus</i> sp.	<i>sequoiae</i> Ashmead
<i>Trypodendron lineatum</i> Olivier	* <i>sequoiae</i> Ashmead
<i>Xyloterinus politus</i> (Say)	<i>stigmatus</i> , sp. n.

Diapause. For establishment of a properly functioning host-parasite relationship, the two species obviously must be not only geographically and ecologically, but seasonally coincident as well. Synchronization of development with host is often accomplished in the parasitic Hymenoptera through the mechanism of diapause, but in these groups it is particularly difficult to unravel the causal factors initiating this state (see Doutt, 1959). Those *Spathius* studied appear to attack only the ultimate or penultimate larval instars (Kaston, 1939), but more than one generation per year may commonly be raised upon the same favorable log, and the meagre information available indicates that different species may be either univoltine or multivoltine (see Fiske, 1907; Kaston, 1937, 1939; Robert, 1951a & b, 1960). Overwintering of most Nearctic species probably is in the prepupal stage, as shown for *S. benefactor* in southern Quebec (Robert, 1960) and in Connecticut (Kaston, 1939).

Adult habits and longevity. *Spathius* is a genus of forested habitats, and the free-living adults are practically never found in open or gravelly situations. Adult females apparently spend most of their time crawling over bark in their search for hosts, and probably have a very short preoviposition period following emergence. There is every indication that the genus is normally diurnal, but rarely females of *brachyurus*, *canadensis* and *brevipalpus* have been collected at light.

Adults of both sexes in at least some species feed upon carbohydrates, and while rarely collected from flowers I have often taken them at sources of homopteran honeydew. In the laboratory, adults feed readily upon a sucrose solution or well-soaked raisins. Adults of the Indian species *S. critolaus* Nixon have been kept alive up to 162 days in the laboratory (see review in Nixon, 1943) but probably the adult life is much shorter under natural conditions.

Sexual dimorphism. Among the Nearctic elements of the genus, sexual dimorphism is not particularly pronounced. It is perhaps most evident in males of the *trifasciatus* group, which have strongly swollen femora; although mating has not been observed, this adaptation might be involved in clasping the female. As a general rule, males are smaller and have the sculpture less well developed, except on tergite (2-3) where the sculpture may often be more extensive than in the female. Because extensive courtship displays have never been observed in the parasitic Hymenoptera, it seems more likely that the banded wings of both sexes function primarily in camouflage or mimicry. Held folded over the body, they often give *Spathius* an ant-like appearance from above.

Courtship and mating. As in most other parasites of wood-boring beetles, *Spathius* presumably mate shortly after the female's emergence, probably while still upon the host tree. This is no doubt an important isolating mechanism,

for it would decrease the chance of sympatric allotrophic species encountering one another during this critical time in their life cycle. This feature of its biology, coupled with the apparently rather stereotyped habits of searching for hosts, has important implications for speciation in the genus and may help explain the existence of so many widely sympatric species in eastern North America.

Resource partitioning. Of special evolutionary interest is the occurrence of several Spathius species attacking beetles (often of the same species) in the same host tree. For example, at least five species have been reared from beetles infesting hickory, at least three of which have been reported for the same host, Magdalis olyra Herbst. Although perhaps not the case in this particular complex, in an analagous situation involving the ichneumonid genus Megarhyssa, the three species were found to be almost completely separated by selection of hosts at depths corresponding to the different ovipositor lengths (Heatwole and Davis, 1965). And while recently a number of investigators have doubted the validity of universally applying the competitive exclusion principle, and there is little information on the biology of these sympatric broadly autotrophic Spathius, it is possible (but not necessarily probable) that mechanisms exist by which the hosts resources are partitioned spacially and/or temporally. For example, at least one species, S. stigmatus, is temporarily isolated, attacking a different beetle assemblage in trees in more advanced conditions of decay (see "Hosts" under stigmatus). Other mechanisms - such as different seasons of adult activity, preferences for different stages of the host beetle or different parts of the host tree, or simply different daily activity cycles - probably also exist behind the apparent coexistence of several species.

Key to the North American Species of Spathius

FEMALES

1. Malar space long, 0.67-1.00x EH; eyes relatively small (Figs. 5, 7 and 8). 2
 Malar space 0.33-0.67x EH, usually about half EH; eyes normal (Figs. 2, 17 and 22). 5
2. Ovipositor very long, at least twice as long as fore wing; gaster with faint aciculation at base of tergite (2-3). 4. stigmatus, new species (p. 32)
 Ovipositor not longer than fore wing; gaster smooth and shining, with no trace of sculpture at base of tergite (2-3). 3
3. Scutellum rugose; vertex and temples smooth; ovipositor 0.69-0.96x FWL; body in profile as in Figure 5. 3. marshi, new species (p. 30)
 Scutellum centrally smooth and flat; vertex and temples coarsely granular to rugulose; ovipositor 0.39-0.60x FWL. 4
4. Maxillary palpi greatly reduced, at most slightly longer than EH; temples broad, from 1.0-1.3x EH (Fig. 7). 2. brevipalpus, new species (p. 29)
 Maxillary palpi normal, at least twice as long as EH; temples less broad, from 0.76-1.04x EH (Fig. 8). 1. brachyurus Ashmead (p. 26)

5. Sternaulus bounded below by a well developed broadly curved carina extending from prepectal carina to mesocoxal cavity (Fig. 14); scutellum conical in profile. 6
 Sternaulus not as above, typically a simple longitudinal furrow extending from prepectal carina posteriorly for about 2/3 length of mesopleuron and crossed by few to many variously developed ridges (Figs. 17 and 22); scutellum at most slightly conical or projecting apically. 7
6. Ovipositor 0.45-0.68x FWL; head and thorax testaceous; first intercubitus and second abscissa of radius subequal in length; profile of thorax as in Figure 14. 19. brunneus Ashmead (p. 70)
 Ovipositor 0.87-1.20x FWL; head and thorax ferruginous to piceous; first intercubitus distinctly longer than second abscissa of radius (Fig. 29).
 18. trifasciatus Riley (p. 66)
7. Head and thorax strongly dorsoventrally compressed (Fig. 17), the pronotum with a distinct dorsal transverse swelling; tergite (2-3) entirely coarsely granular (except extreme apical margin) and lateral margin thickened over nearly entire length; subdiscoideus vein typically interstitial (Fig. 18).
 5. calligaster, new species (p. 35)
 Head and thorax not strongly flattened, or if apparently so then other characters not as above; lateral margin of tergite (2-3) at most thickened on basal half; subdiscoideus arising from upper half of brachial cell.
 8
8. Petiole straight, slender and elongate (Fig. 22), usually much greater than 1.5x as long as middle femur; ovipositor long, 1.05-2.1x FWL. . . . 9*
 Petiole usually distinctly arched at base (similar to that shown in Fig. 5) and more stout, always shorter than 1.5x middle femur. 10
9. Ovipositor very long, 1.6-2.1x FWL; hind tarsomere 3 distinctly longer than 5; hind basitarsus not more than 2.1x as long as second tarsomere; antennae with 35-48 flagellomeres. . . 8. evansi, new species (p. 42)
 Ovipositor 1.05-1.55x FWL; hind tarsomere 3 subequal or slightly shorter than 5; hind basitarsus 2.1-2.9x as long as second tarsomere; antennae with 30-38 flagellomeres; propodeum often much lighter than remainder of thorax, distinctly contrasting even to the naked eye.
 7. elegans, new species (p. 39)
10. Vertex entirely strongly granular-strigose and very deep (OED/OOD 0.56-0.78, Fig. 24), the sculpture extending undiminished to eyes and over ocellar triangle, frons and entire temples nearly to malar space; scutellar furrow carinae often irregular or rugose. 11
 Vertex not as above, usually narrower (OED/OOD 0.58-1.11) and either entirely or partly smooth (at least adjacent to eyes) or, if apparently completely sculptured, then this in the form of transverse strigosity with little evidence of the granular element; scutellar furrow carinae usually simple and more or less straight. 12

* The unknown female of longipetiolatus Ashmead from Florida will presumably also run out to this point in the key.

11. Gastral tergites 4-6 each with a well developed broad transverse punctulate band anterior to the row of setae; mesopleural disc above and posterior to sternaulus evenly granular to scaly-reticulate; outer apical margin of hind tibia with a row of 4-6 spines, typically 5.
 20. simillimus Ashmead (p. 72)
 Gastral tergites nearly smooth and shining, with at most weak scaly-reticulate sculpture on about basal half of tergite (2-3); mesopleural disc above sternaulus with variously expressed strigosity; outer apical margin of hind tibia with a row of 2-4 spines, typically 3.
 21. floridanus Ashmead (p. 75)
12. Ovipositor very short, 0.32-0.46x FWL; vertex smooth and shining; ratio of petiole length to dorsal length of tergite (2-3) 1.22-1.30; fore wing subhyaline (Fig. 26); western North America.
 11. aphenges, new species (p. 51)
 Ovipositor usually greater than .45x FWL; if shorter, then vertex at least partly sculptured; ratio of petiole length to dorsal length of tergite (2-3) variable, 1.26-2.00; fore wings variously infumated. 13
13. Ovipositor 0.91-1.57x FWL; vertex strongly transversely strigose of uniform intensity from ocellar triangle to occipital carina, becoming granular at eyes; TW/EH 0.63-0.78, and OED/OOD 0.64-0.82.
 15. comes, new species (p. 59)
 Ovipositor shorter, 0.33-1.09x FWL; if ovipositor is greater than 0.91x FWL then either vertex is only faintly strigose, becoming smooth at eyes, or temples and vertex are narrow, TW/EH less than 0.63 and OED/OOD greater than 0.85. 14
14. Outer apical lobe of hind tibia with a row of 6-8 conspicuous spines (Fig. 23); mesopleural disc above sternaulus smooth and shining; body length, exclusive of ovipositor and antennae, 3.5-6.1 mm; antennae with 29-42 flagellomeres. 17. laflammei Provancher (p. 64)
 Outer apical lobe of hind tibia with at most 6 spines, usually 2-5; mesopleural disc variable; smaller species, body length 1.7-4.3 mm; antennae with 20-33 flagellomeres. 15
15. Fore wings weakly infumated to subhyaline (Fig. 28), rarely with complete dark transverse bands; vertex from nearly smooth and shining to delicately transversely strigose; head and thorax usually dark, ferruginous to piceous; eyes gray, rarely weakly iridescent greenish in white light.
 16
 Fore wings with two dark well defined transverse bands separated by a hyaline band through the basal 1/3 of stigma (Figs. 28-31); vertex variable, sometimes nearly smooth, but often with well developed transverse strigosity; head and thorax testaceous to ferruginous; eyes typically bright iridescent greenish in white light. 17
16. Ovipositor 0.45-0.65x FWL; tergite (2-3) usually with a distinct area of sculpture on about basal 0.37-0.45, and occasionally with additional sculpture on middle third of tergite and/or weak transverse punctulate bands on some subsequent tergites; body length 2.0-3.8 mm.
 10. canadensis Ashmead (p. 47)

- Ovipositor 0.60-0.80x FWL; tergite (2-3) either nearly smooth or with at most weak mostly obscured sculpture on about basal 0.38 of tergite; body length 2.5-4.1 mm; western North America.
 9. sequoiae Ashmead (p. 44)
17. Vertex very narrow, OED/OOD 0.80-1.11; outer apical margin of hind tibia with at most 4 rather inconspicuous spines, typically 2-3, situated anteriorly (Fig. 18). 18
 Vertex broader, OED/OOD 0.70-0.83; outer apical margin of hind tibia with a row of 3-6 spines. 19
18. Ovipositor 0.35-0.64x FWL; tergite (2-3) with sculpture present on about basal 0.65-0.75; vertex striae delicate, tending to bend medially toward ocellar triangle and blend into its granular sculpture (Fig. 25).
 13. parvulus, new species (p. 55)
 Ovipositor 0.50-1.02x FWL; tergite (2-3) with sculpture on at most about basal 0.40 of tergite, remaining tergites smooth; vertex striae more or less transverse, not notably indented medially.
 14. impus, new species (p. 56)
19. Body color wholly tawny yellow to dirty brown, the gaster beyond basal 2/3 of tergite (2-3) occasionally slightly darker or with darker bands; vertex more or less evenly transversely strigose; mesopleural disc with delicately swirled strigosity above sternaulus.
 12. pallidus Ashmead (p. 53)
 Body color shining ferrugineous, with about apical half of petiole to middle of tergite (2-3) distinctly lighter, suffused with yellow or rufo-testaceous; vertex anteriorly delicately transversely strigose and shining; mesopleural disc above sternaulus smooth and shining or occasionally weakly scaly-reticulate.
 16. benefactor, new species (p. 61)

MALES

1. Scutellum flat, centrally smooth; propodeum with a prominent tubercle projecting from each posterior-dorsal-lateral angle; vertex, temples and mesopleura rugulose. 1. brachyurus Ashmead* (p. 26)
 Scutellum granular or rugose and at least weakly convex; posterior dorsal-lateral angles of propodeum not produced; sculpture of vertex and temples variable. 2
2. Hind wing with a well developed stigma-like thickening at the junction of the costella, basella and radiella veins (Fig. 13); eyes small, the temples broad, TW/EH 0.90-1.04; antennae much shorter than body.
 4. stigmatus, new species (p. 32)
 Hind wing not as above, if apparently with a weak stigma-like thickening then TW/EH less than 0.90 and antennae about as long as body. . . . 3
3. Scutellum rugose; gaster smooth and shining; body in profile as in Figure 5, the propodeum with a distinct tooth-like projection due to the strongly

* The unknown male of brevipalpus, sp. n. will presumably also run to this point.

- protuberant carina separating the areola and area petiolaris.
 3. marshi, new species (p. 30)
 Scutellum evenly scaly-reticulate to granular; gaster variable but often
 with distinct sculpture at least at the base of tergite (2-3); propodeum
 not as above. 4
4. Sternaulus bounded below by a well developed broadly curved carina extend-
 ing from prepectal carina to mesocoxal cavity (Fig. 14); femora strongly
 swollen (Fig. 15); scutellum conical in profile. 5
 Sternaulus not as above, typically a simple longitudinal furrow extending
 from prepectal carina posteriorly for about 2/3 length of mesopleuron
 and crossed by few to many variously developed ridges (see Figs. 17 and
 22); femora not particularly swollen (Fig. 16); scutellum at most slightly
 conical or projecting apically. 6
5. First intercubitus distinctly longer than second abscissa of radius (Fig. 29);
 area where notauli converge rugose and strongly depressed between the
 lateral lobes of mesonotum. 18. trifasciatus Riley (p. 66)
 First intercubitus sub-equal to second abscissa of radius; area of notauli
 convergence shallowly depressed and not strongly rugose.
 19. brunneus Ashmead (p. 70)
6. Head and thorax strongly dorsoventrally compressed (Fig. 17); at least
 tergites (2-3) and 4 uniformly granular (except apical margin).
 5. calligaster, new species (p. 35)
 Head and thorax not strongly dorsoventrally flattened; well-developed
 granular sculpture rarely covering more than basal 3/4 of tergite (2-3).
 7
7. Petiole elongate, slender and nearly straight (Fig. 22), longer than 1.6x
 length of middle femur. 8
 Petiole shorter, usually distinctly arched at base (similar to that shown in
 Fig. 5), always less than 1.55x length of middle femur. 10
8. Antennae with 22-25 flagellomeres; tergite (2-3) with at most weak acicula-
 tion at extreme base; mesopleural disc above sternaulus smooth.
 6. longipetiolatus Ashmead (p. 38)
 Antennae with more than 25 flagellomeres; tergite (2-3) with well-developed
 sculpture on at least basal half; mesopleural disc above sternaulus granu-
 lar to rugose. 9
9. Vertex (and often frons) smooth, shining; sculpture on middle area of
 tergite (2-3) often partially obscured, but when present, always much
 less strongly developed than that of basal half of tergite and separated
 from it by a narrow smooth space; mesopleural disc above sternaulus
 typically scaly-reticulate to irregularly wrinkled.
 7. elegans, new species (p. 39)
 Vertex usually with faint transverse strigosity anteriorly; sculpture of ter-
 gite (2-3) covering about 3/4 of tergite and uninterrupted at middle by a
 smooth space, gradually diminishing in intensity apically; mesopleural
 disc above sternaulus uniformly granular.
 8. evansi, new species (p. 42)

10. Vertex entirely prominently granular-strigose and very wide (OED/OOD 0.56-0.78, Fig. 24), the sculpture extending undiminished to eyes and over ocellar triangle, frons, and entire temples nearly to malar space; scutellar furrow carinae often irregularly wrinkled. 11
 Vertex not as above, usually narrower (OED/OOD 0.60-1.11) and either all or partly smooth (at least adjacent to eyes), or if apparently completely sculptured then this in the form of transverse striation with little evidence of the granular element; scutellar furrow carinae usually simple and more or less straight. 12
11. Gastral tergites 4-6 each with a well developed broad transverse punctulate band anterior to the row of setae. 20. simillimus Ashmead (p. 72)
 Gastral tergites nearly smooth and shining, with at most scaly-reticulate sculpture on about basal half of tergite (2-3).
 21. floridanus Ashmead (p. 75)
12. Species occurring west of 100th meridian. 13
 Species occurring east of 100th meridian. 16
13. TW/EH 0.50-0.67; eyes iridescent greenish in white light; fore wings with complete lightly infumated transverse bands (Fig. 30); vertex sculpture, when present, as in Figure 25. 13. parvulus, new species (p. 55)
 TW/EH 0.67-0.85; eyes gray, at most faintly iridescent; fore wings hyaline to weakly infumated in area of radial cell (Figs. 26 and 27). 14
14. Frons nearly smooth, with faint traces of incomplete transverse striation; space posterior to sternaulus smooth to faintly scaly-reticulate.
 11. aphenges, new species (p. 51)
 Frons wholly delicately transversely striate, this sculpture often continuing dorsally onto vertex; space posterior to sternaulus with about 2-6 closely spaced gently curved longitudinal ridges. 15
15. Ratio of lengths of hind tarsus to hind tibia 0.66-0.88; mesopleural disc above sternaulus delicately strigose. 9. sequoiae Ashmead (p. 44)
 Ratio of lengths of hind tarsus to hind tibia 0.84-0.96; mesopleural disc above sternaulus scaly-reticulate. 10. canadensis Ashmead (p. 47)
16. Vertex distinctly delicately to strongly transversely strigose of more or less uniform intensity from ocellar triangle to occipital carina. 17
 Vertex nearly smooth, or if delicately strigose this only on about anterior half, the part adjacent to occipital carina becoming smooth. 20
17. Sculpture of tergite (2-3) covering no more than basal half of tergite (rarely faint scaly-reticulation beyond middle of tergite); remaining tergites smooth. 18
 Tergite (2-3) with distinct sculpture developed beyond middle, this usually less extensive and of less intensity than sculpture on basal portion; remaining tergites (especially tergite 4) often with distinct punctulation or scaly-reticulation anterior to the setae. 19
18. Temples wide, TW/EH 0.63-0.88; hind tarsomere 2 distinctly longer than tarsomere 5 (not including claw).
 15. comes, new species (p. 59)

- Temples narrow, TW/EH 0.50-0.63; hind tarsomere 2 subequal to tarsomere 5 (not including claw). 14. impus, new species (p. 56)
19. Vertex narrow, OED/OOD 0.80-1.00 (Fig. 25).
 13. parvulus, new species (p. 55)
 Vertex slightly broader, OED/OOD 0.70-0.81.
 12. pallidus Ashmead (p. 53)
20. Outer apical margin of hind tibia with 5-8 strong spines, usually 6 or 7 (Fig. 23); mesopleural disc smooth immediately above sternaulus; vertex wide, OED/OOD 0.58-0.78. . . . 17. laflammei Provancher (p. 64)
 Outer apical margin of hind tibia with 2-5 spines; mesopleural disc sculpture and vertex width variable. 21
21. Eyes usually bright iridescent greenish in white light; mesopleural disc above sternaulus smooth (rarely weakly scaly-reticulate); fore wings distinctly weakly banded, rarely subhyaline. 22
 Eyes dark gray; mesopleural disc above sternaulus scaly-reticulate to delicately strigose; wings typically hyaline, at most weakly infumated in area of radial cell. 10. canadensis Ashmead (p. 47)
22. Vertex narrow, OED/OOD 0.85-1.11; head and thorax predominantly dirty yellow. 14. impus, new species (p. 56)
 Vertex wider, OED/OOD 0.67-0.88; head and thorax predominantly dull ferrugineous. 16. benefactor, new species (p. 61)

1. Spathius brachyurus Ashmead

(Figs. 8, 10)

Rhopalophorus fasciatus Provancher, 1886, Naturaliste can. 16: 129. (nec Spathius fasciatus Walker, 1874, Cist. Ent. 1: 307.) [Type locality: Ontario: Ottawa (lectotype female in Laval Univ., Quebec)].

Eustalocerus fasciatus (Provancher), 1888, Naturaliste can. 18: 378.

Spathius brevicaudus Ashmead, 1892, in Hopkins, Insect Life 4: 258. Nomen nudum.

Spathius brachyurus Ashmead, 1893, Can. Ent. 25: 71, 73. [Type locality: West Virginia: Morgantown (A. D. Hopkins) (lectotype female in USNM, Type No. 2151)].

Spathius dignus Muesebeck and Walkley, 1951, Agriculture Monogr. 2: 169, new name for fasciatus Provancher. New synonymy.

Females: Body length, 3.0-5.3 mm; FWL, 2.3-3.4 mm; ovipositor sheath length, 1.0-1.9 mm. Other measurements and ratios in Table 1.

Head: Antennae short, about as long as FWL; flagellomeres 19-25, those beyond the first subcubical, less than 2x as long as wide, each with a corona of 4 evenly spaced erect setae about 2x as long as all other flagellar setae; eyes sparsely covered with short setae; face coarsely granular to rugose; frons granular to rugose-reticulate, becoming granular in area of ocellar triangle; vertex granular adjacent to ocellar triangle, becoming rugose striate posteriorly; temples rugose striate to coarsely granular; malar space and ocellar triangle finely granular; mandibles striate below at base, the tips dark; maxillary palpi slightly reduced, extending to about posterior border of fore coxae.

Thorax: Lateral areas of prothorax distinct, well developed, delimited by a distinct carina with several cross carinae; remainder of propleura coarsely granular; notauli deeply impressed anteriorly, converging to a slightly depressed rugose-reticulate area; mesonotum abruptly declivous, the lobes evenly granular, the middle lobe often with a weak medial longitudinal furrow; scutellar furrow with 4 to 7 cross carinae, often with some more strongly developed than others; scutellum flat, centrally smooth, the posterior margin sometimes granular; mesopleural disc granular to rugose; sternaulus most strongly impressed posteriorly, with 7 to 12 cross carinae superimposed on a granular background, an irregular carina sometimes developed along the posterodorsal margin; prepectal carina complete; prepectal area smooth to weakly granular; dorsal areas and sides of propodeum coarsely granular to reticulate; all propodeal carinae well developed and prominent, the basal carina about equal to its forks; areola and area petiolaris crossed by several transverse carinae; posterior-dorsal-lateral propodeal angles distinctly produced to form well developed tubercles; fore tibia with 12-16 spines in an irregular single row and a row of 6 at apex; outer apical lobe of hind tibia with a row of 3-4 rather elongate spines; hind coxae angled basally below, ventrally coarsely granular with some oblique striations dorsally; fore coxae smooth; middle coxae granular dorsally, smooth ventrally; second abscissa of radius decidedly longer than first intercubitus; subdiscoideus arising from upper half of brachial cell; tegulae smooth.

Abdomen: Petiole arched at base, longitudinally striate dorsally; gaster entirely smooth and polished except ultimate tergite which bears longitudinal striations on basal half (these usually not visible unless tergites are distended) and a granular ventral apical margin; tergite (2-3) without thickened lateral margins, but occasionally with faint aciculation at extreme base.

Color: Body color varying from uniformly testaceous (*S. dignus*) to dark ferruginous or castaneous; in some individuals, propodeum, petiole and most of tergite (2-3) are distinctly lighter than remainder of body; legs usually concolorous with body, though in some specimens lighter, especially basal segments; tibiae not or indistinctly banded at base; clypeus, basal antennal segments and mandible bases sometimes suffused with dirty yellow; ovipositor sheath tips and apical 6-8 flagellomeres darker than respective basal portions, often brown; flagellomeres each with a narrow darker apical band; fore wing as in Figure 10, wings of males and lighter individuals approaching a subhyaline condition; costa, media and basal veins and stigma brown, remaining veins light brown or tan.

Males: Agree with females in all essential features except for the laterally thickened margin of tergite (2-3) and flagellum more slender, the first 5 flagellomeres more than 2x as long as wide; intensity of body sculpture, especially of vertex and temples, sometimes reduced; color variation also similar to that of females.

Remarks: Through the courtesy of Dr. René Béique, I have examined Provancher's type of *Rhopalophorus fasciatus** (renamed *Spathius dignus* by Muesebeck and Walkley, 1951) and see no justification for retaining it as a separate species. It agrees with the typical *S. brachyurus* in every respect except that it is a very light-colored individual, being wholly testaceous except for a darker gaster beyond tergite (2-3), but falls readily within the range of

* The lectotype of *Rhopalophorus fasciatus* bears a blue label with the handwritten number 701 and a yellow label with the printed number 1281, and a lectotype label by P. M. Marsh, Feb. , 1965. The abdomen is broken off and glued to the blue label. See also Gahan and Rohwer, 1917, and Shenefelt, 1968.

color variation exhibited by the material of S. brachyurus before me. Since fasciatus is preoccupied by Walker (1874), Spathius brachyurus Ashmead becomes the oldest available name for the species, and S. dignus Muesebeck and Walkley falls as a synonym.

Following his description of S. brachyurus, Ashmead states "bred Nov. 10, 1890, and March 15, 1891, from Dryocoetes autographus living under bark of dead Abies excelsa ..." (see also Hopkins, 1892). According to the original Hopkins manuscript on file in the U. S. National Museum, specimens matching these data bear the numbers 5139 and 167 respectively. In the U. S. National Museum collection are two pins bearing the label "5139 Hopk. W. Va."* One has four specimens of S. brachyurus, each on a separate point, and a cluster of cocoons beneath on the pin. The other bears two specimens, each on a separate point. The former has two additional labels, "Spathius brachyurus Ashm. ♀" in Ashmead's writing and a red label "Type No. 2151 USNM". Of the four original specimens, one is completely gone, a second broken and the other two females in good condition. I have placed a red ink mark near the base of the point of one of the good females, and here designate this female as the lectotype. The other specimens having the number 5139 have been labeled as paralectotypes.

The number 167 is on the label of one specimen of Spathius in the U. S. National Museum collection; however, this specimen is definitely not S. brachyurus, but S. canadensis. Also in the U. S. National Museum are one female, one male, and two cocoons, all on a pin of S. brachyurus bearing the number 2442; this number is also on Hopkin's original manuscript, with the same host data except that the adults emerged April 6, 1891. Presumably Ashmead must also have had these before him when he described S. brachyurus, even though he did not specifically mention any males in his description; thus, I am designating these also as paralectotypes.

In summary, 3 pins bearing a total of 7 intact specimens (6♀♀, 1♂) are believed to have been part of the original material on which Ashmead based his description of S. brachyurus; one of these has been designated as lectotype and the others as paralectotypes.

Diagnosis: This species may be distinguished from its closest relative, S. brevipalpus, sp. n., by head shape, especially the less broad temples (Fig. 8), by the more elongate maxillary palpi, and by having the gastral setae arranged in a more or less distinct row on each tergite as opposed to the scattered arrangement in two or three rows per tergite characteristic of brevipalpus. Both may be readily separated from all other North American Spathius by the combination of propodeal tubercle, flat scutellum, polished gaster and coarsely sculptured head.

Distribution: Eastern North America north of North Carolina and Tennessee. I have seen specimens from Connecticut, Massachusetts, New Hampshire, New York, North Carolina, Ohio, Rhode Island, Tennessee, Virginia, West Virginia, Wisconsin, and Quebec, Canada. Also, in the U. S. National Museum is one broken specimen labeled from the Chiricahua Mountains of Arizona; this is possibly a labeling error.

* The Hopkins manuscript has two numbers 5139. The first is indicated as bred from a curculionid under Pinus inops bark, Sept. 28; the second bears the data cited in Ashmead's description; however, this second number was originally typed as 5189, with the 8 subsequently written over as a 3. I suspect the first 5139 should then have been changed to 5189.

Biology: Except for host records, nothing is recorded for this species. However, a cluster of 7 cocoons pinned with an equal number of adults (6♀♀, 1♂) from Branford, Connecticut (CAES), indicates that *S. brachyurus*, like *S. floridanus*, has multiple oviposition in a single host.

Hosts: Published host records for *S. brachyurus* include *Pissodes strobi* (Peck) (Curculionidae) in pine and the scolytids *Dryocoetes autographus* (Ratzeburg) in spruce and *Phloeosinus dentatus* (Say) in red cedar. A summary of the literature references to these hosts may be found in Bushing (1965). The last-named host is probably erroneous, the original record (Riley and Howard, 1890) referring to a manuscript species, *Spathius abdominalis* Riley,* and there are no later records to substantiate it. No host records were published for *S. dignus*.

The only new host record is *Pissodes approximatus* Hopkins in Scotch pine from Virginia (Hopkins No. 10099t¹). Host trees from which *S. brachyurus* has been reared include *Picea* spp., *Abies* spp. and *Pinus* spp. (mostly *strobus*); a series of females from Wood Co., Wisconsin (RDS), is labeled from light trap.

2. *Spathius brevipalpus*, new species

(Figs. 7, 11)

Holotype. - female, North Carolina: Salisbury (J. S. Pinckney). [USNM Type No. 70498].

Description of type female: Body length, 3.3 mm; FWL, 2.2 mm; ovipositor sheath length, 1.2 mm. Other measurements and ratios in Table 1.

This species is very close to *S. brachyurus* and may be compared to it as follows:

Head: Sculpture as in *S. brachyurus*; face in profile distinctly more protuberant (Fig. 7); antennae about as long as FWL, inserted on a distinct frontal prominence; flagellomeres 19, those beyond the first subcubical, less than 2x as long as wide and lacking a corona of distinctly longer setae; eyes smaller, resulting in a longer TW and MS (see Table 1); maxillary palpi (Fig. 7) greatly reduced, total length not longer than EH; hypostomal carina highly protuberant to form a strong lip.

Thorax: Like *S. brachyurus* except as follows: lateral area of prothorax less distinctly delimited posteriorly; scutellar disc delicately granular at margins; mesopleura and sternauli uniformly very coarsely granular, sternauli lacking distinct cross carinae; fore tibia with an irregular row of about 15 spines and a row of 4 spines at apex; outer apical lobe of hind tibia with 3 spines; basal carinae of propodeum about half as long as its forks, all propodeal carinae strongly developed.

Abdomen: As in *S. brachyurus* except tergites have more setae, in two or three irregular rows per tergite, as opposed to the single obvious row per ter-

* Riley's manuscript species was never formally described and is therefore a *nomen nudum*. Indications in the Hopkins Card File in the USNM suggest that this species was conspecific with *S. brachyurus* Ashmead; this may have been the basis for its host record being transferred to that species, first by Chamberlin (1939).

gite in *S. brachyurus*; base of tergite (2-3) weakly aciculated.

Color: Body uniformly testaceous; antennae uniformly testaceous, flagellomeres lacking a darker apical band; wings hyaline (Fig. 11), no trace of a band, all veins and stigma uniformly light brown or tan (second intercubitus and intersection of recurrens, first cubitus and first intercubitus not effaced).

Variation: Paratype females. Major variation is in color, the two paratypes being more darkly pigmented than the type, the one from Raleigh, North Carolina, almost uniformly brown. The spines on the fore tibiae are difficult to see and count accurately.

Male: Unknown.

Paratypes: North Carolina: Raleigh, 1♀, 1 Sept. 1947, light (M. W. Wing) [USNM]. South Carolina: Spartansburg, 1♀, Hopk. No. 11209a³ (T. E. Snyder) [USNM].

Remarks: This unique species is readily distinguished from all other North American *Spathius* by the greatly reduced maxillary palpi which are the basis for the specific name, *brevipalpus*.

Distribution: Aside from the type material, two additional broken female specimens are in the U. S. National Museum collection, one from Durham, N. C., the other from Jacksonville, Texas. This suggests that *S. brevipalpus* probably has a range covering the southeastern United States west to Texas.

Hosts: The paratype with Hopkins No. 11209a³ was bred from "red top pine"; a list of associated insects is under this number in the Hopkins card file at the U. S. National Museum. The label on the specimen from Durham, N. C., states "ex *Pachylobius picivorus*", a curculionid, a record which should await further confirmation.

3. *Spathius marshi*, new species

(Figs. 4, 5, 9)

Holotype. - female, Maryland: Patuxtent [= Patuxent] Wildlife Ref. (P. M. Marsh). [USNM Type No. 70499].

Description of type female: Body length, 3.3 mm; FWL, 2.6 mm; ovipositor sheath length, 1.8 mm. Other measurements and ratios in Table 1.

Head: Antennae slender, about 1.3x FWL; flagellomeres 22 right side, 23 left side, each with apical corona of 4 erect setae, about 2x as long as other flagellomere setae; face smooth with transversely wrinkled striations; frons smooth with delicate transverse striations centrally; vertex smooth, temples smooth, except faint raised rugosities paralleling occipital carina posteriorly; malar space smooth; occipital carina with several irregular short anteriorly directed branches laterally (Fig. 5); ocellar triangle slightly raised, smooth; eyes reduced, sparsely covered with short setae.

Thorax: Lateral area of prothorax deeply excavated, smooth and relatively broad, delimited by well defined carinae (Fig. 5); mesonotum moderately declivous, the lobes coarsely rugose with granular centers; notauli foveolate, deeply impressed and slightly lighter than mesonotal lobes; scutellar furrow deeply excavated, the anterior and posterior margins scalloped on either side of a well developed median cross carina; scutellar disc rugose; mesopleural disc smooth; sternaulus (Fig. 5) divided into two deep foveae by a strong median cross carina, a well developed longitudinal carina extending posteriorly to the mesocoxal cavity, forking about midway; prepectal carina complete; prepectal area smooth with two weak horizontal carinae; fore tibia with 24 spines

arranged in an irregular double row, a row of 5 spines at apex; hind tibiae with raised parallel longitudinal ridges below, outer apical lobes with 3 spines; fore and mid coxae smooth, hind coxae rugulose; hind tarsal segment 1 about 2.4x segment 2; second abscissa of radius distinctly longer than first intercubitus; subdiscoideus arising above middle of brachial cell; propodeal carinae all well developed, without trace of lateral branches (Fig. 4); basal carina about 1.3x the basal forks; segments of basal forks subequal on either side of costula insertion; dorsal areas and areola with reticulate surface rugosity; area petiolaris rectangular, about 3x as long as wide, subequal to the pentagonal areola in length, the carina separating them strongly protuberant and visible as a distinct toothlike projection in profile (Fig. 5); posterior-dorsal-lateral angles very weakly protuberant.

Abdomen: Petiole arched and dorsoventrally thickened at spiracles (Fig. 5), with smooth longitudinal striations dorsally; gaster smooth and shining, with no trace of surface sculpture; lateral margins of tergite (2-3) not thickened basally.

Color: Head shining orange brown, except face and malar area suffused with yellow; maxillary and labial palpi stramineous; mandibles testaceous except teeth darker; scape, pedicel and basal flagellar segments yellow brown, flagellum becoming gradually light brown apically; thorax, propodeum, petiole and gaster ferruginous except prothorax which is testaceous; gaster shining, the tergites with ill-defined subapical, subcuticular testaceous bands; legs yellow brown except ferruginous hind femora, tibiae not or indistinctly banded at base; wings (Fig. 9) subhyaline, costa and basal third of stigma tan, other veins and remainder of stigma medium brown; tegulae testaceous, shining; ovipositor sheaths yellow brown basally, becoming gradually brown toward apex.

Variation: Paratype females. In addition to characters given in Table 1, minor variations in number and development of the cross carinae of the scutellar furrow, sternauli and area petiolaris occur, with up to 4 distinct scutellar carinae and the sternauli either undivided or comprised of as many as 4 foveae. The number of fore tibial spines varies from 17 to 26. The Maine paratype differs from the others as follows: the sternauli are merely deep depressions without thickened margins (hence not true foveae) and the carina extending from the posterior margin to the mesocoxal cavity is totally effaced on the anterior half; the prepectal carina is incomplete medially and there are additional short horizontal carinae immediately above the prepectal area, which has in addition a medial vertical carina; instead of delicate transverse striae, the frons has delicate irregular raised rugosities medially; the petiole arches distinctly beyond the spiracles at about its geometric midpoint; the carina between the area petiolaris and areola is not protuberant and the forks of the basal carina are distinctly arched instead of straight. While these differences may prove to merit specific designation, I chose to include it here until more material is available.

Paratype males: The two known males agree with the holotype in color and sculpture, except they have the frons smooth, the petiole more slender and elongate, and one from Virginia lacks median cross carinae on the sternauli.

Paratypes: 1♀, same data as holotype [USNM]. Iowa: Mt. Pleasant, 1♀, 26 May 1934 [USNM]. Kansas: Onaga, 1♀, 2 June 1923 (Crevecoeur) [KSU]. Maine: Round Mt., 1♀, 16 July [MCZ]. Maryland: nr. Colesville, 1♀, 28 May 1914 (R. C. Shannon) [USNM]; Beltsville, 1♀, April 1941 (A. E. Davis) [USNM]. Michigan: Ann Arbor, 1♀, 29 May 1962 (H. & M. Townes) [Townes]; St. Joseph Co., 1♀, 5 Aug. 1953 (R. R. Dreisbach) [Townes]; Wayne Co., Grosse Isle, 1♀, 13 Aug. 1956 (G. Steyskal) [Townes]. New York: Chappagua,

1♀, 18 May 1937 (L. L. Pechuman) [USNM]. Pennsylvania: Stoverdale, 1♀, 25 Aug. 1916 (W. S. Fisher) [USNM]. Tennessee: Chapin Sanctuary, East Ridge, 1♂, 9 May 1952 (O. Peck) [CNC]. Virginia: Arlington, 1♂, 8 Sept. 1952 (K. V. Krombein) [USNM].

Remarks: This species may be distinguished from all other North American *Spathius* by the smooth mesopleural disc and the rugose scutellum and mesonotal lobes. The unique form of the sternauli, lack of banded wings, and propodeal profile (Fig. 5) are also useful diagnostic characters. Interestingly, a very similar propodeal profile also occurs in *S. cassidoris* Nixon from New Guinea (Nixon, 1943, p. 268). This distinctive species is named for its collector, Dr. Paul M. Marsh, in grateful appreciation for his continued interest and encouragement throughout this study.

Distribution: The localities of the paratypes indicate that the range of *S. marshi* is apparently eastern North America north of Virginia and Tennessee and west to Iowa. In addition to the paratypes, I have seen specimens from Illinois and Quebec, Canada.

Host: No hosts are known. The New York paratype is labeled from apple, and that from Pennsylvania from hickory.

4. *Spathius stigmatus*, new species

(Figs. 6, 12, 13)

Holotype: - female, New York: Ithaca, 17 Aug. 1947 [CNC].

Description of type female: Body length, 4.4 mm; FWL, 2.9 mm; ovipositor sheath length, 7.5 mm. Other measurements and ratios in Table 1.

Head: Antennae short, about equal to FWL; flagellomeres 18, subcubical, those beyond the third less than 2x as long as wide; flagellomeres each with a corona of 4 evenly spaced erect elongate setae about 4x as long as other flagellar setae (Fig. 6); face transversely striate; frons centrally delicately transversely striate, becoming faintly granular toward eyes and antennal bases; vertex adjacent to ocellar triangle smooth, posteriorly becoming delicately transversely striate, this continuing laterally onto temples to malar space; mandibles striate basally below, the tips dark; ocellar triangle weakly raised, appearing smooth; maxillary palpi slightly reduced, extending to about posterior border of forecoxae, the segments laterally compressed and gently curved, the apparent second longer than any other segment.

Thorax: Lateral area of prothorax narrow and poorly defined; propleura horizontally carinate; mesonotum moderately declivous, the lobes evenly granular; notauli deeply impressed anteriorly, converging to a broad, slightly depressed longitudinally rugose area; scutellar furrow with about 10 evenly spaced cross carinae; scutellum trapezoidal, about as long as basal width and slightly convex, its disc uniformly granular, becoming weakly rugose posteriorly; mesopleural disc finely horizontally strigose; sternaulus shallow, crossed by about 10 moderately developed carinae, these continuing posteriodorsally onto mesopleural disc; prepectal carina complete; prepectal area with irregular surface rugosities and about 4 to 6 short horizontal carinae arising along anterior margin and extending posteriorly about to middle of area; propodeal carinae basad of costulae obscured, entire dorsal area uniformly granular, becoming rugose-reticulate apically; dorsal and lateral carinae well developed, as are those enclosing the almost square area petiolaris; posterior-dorsal propodeal angles weakly protuberant; tegulae delicately shagreened; fore tibia with 13

spines arranged in an irregular single row, a row of 6 spines at apex; outer apical lobe of hind tibia with a row of 4 rather stout spines; hind coxae angled basally below; hind tarsi shorter than hind tibiae, the basitarsi about 2.3x as long as the second tarsomeres; second abscissa of radius about 1.8x first intercubitus; recurrens about equal to first abscissa of radius; subdiscoideus nearly interstitial.

Abdomen: Petiole slightly arched at base, about equal in length to tergite (2-3); petiole sculpture dorsally granular except finely longitudinally striate on apical 1/4 with a pair of longitudinal dorsal carinae along each side; tergite (2-3) smooth except for fine aciculation at extreme base, the lateral margin weakly thickened at base; remainder of gaster appearing uniformly delicately shagreened, strongest on epipleurites; ultimate tergite with fine basal longitudinal striations (not visible unless tergites are distended).

Color: Head, thorax, propodeum, legs and petiole ferrugineous; gaster castaneous, lighter at apex ventrally; maxillary and labial palpi light brown; antennae light ferrugineous, the apical 6-8 flagellomeres becoming brown and all flagellomeres with a narrow darker apical band; tibiae lightened on about basal 1/4, appearing banded, this most apparent on hind tibiae; wings (Fig. 12) infumated except subhyaline tips and a transverse band from the stigma base; veins and stigma (except base) light brown; ovipositor sheaths ferrugineous, the tips dark brown.

Variation: Paratype females. Gaster color in 2 females is completely light ferrugineous. In others, tergite (2-3) is all or in part ferrugineous, the remainder of the gaster being castaneous. The lighter specimens also show a reduction in wing and leg band intensity. In about half of the paratypes, the subdiscoideus is exactly interstitial. In sculpture, basal aciculation of tergite (2-3) covers as much as the basal 1/3 of the tergite in some specimens and carinae development on the prepectal area may be reduced or sometimes entirely absent. Number of scutellar furrow carinae varies from 10 to 15, and number of fore tibial spines from 12 to 15. Variation in measurements and ratios is given in Table 1.

Paratype males: The five male paratypes agree with the females in all important respects except the hind wings show distinct stigmal development (Fig. 13) and the margin of tergite (2-3) is thickened for 2/3 of its length.

Paratypes: 2♀♀, 1♂, same data as holotype [CNC]. Delaware: New Castle Co., 2♀♀, 5 & 7 June 1922 (F. M. Jones) [Townes]. Illinois: Urbana, 1♀, 12 July 1920 (C. P. A.) [INHS]; Elsah, Jersey Co., Principia College, 1♀, 27 April 1943 (C. L. Remington) [USNM]. Maryland: Forest Glen, 1♀, 26 Apr. 1914 (O. Heidemann) [USNM]. Michigan: Livingston Co., G. Res., 1♀, 28 May 1944 (R. R. Dreisbach) [RDS]. New York: Syracuse, 2♀♀, 2♂♂, 21 Mar. & 26 May 1916, N. Y. S. Coll. For. Lot Nos. H295, H438 (M. W. Blackman and H. H. Stage) [Syracuse, Hamden]. North Carolina: Tryon, 3♀♀, Hopk. No. 3605c and 1464f (W. F. Fiske) [USNM]. Ohio: Wayne Co., 1♀, 2 July 1941 [OSU]. Pennsylvania: Hopk. No. 10383 (Linglestown), 7♀♀, 25 June 1914 (H. B. Kirk) [USNM, MCZ]. Texas: Hopk. No. 3861 (Montell), 1♂, April 1907 [USNM]. Virginia: E. Falls Church, 1♀, 9 May 1909 (H. L. Viereck) [USNM]. Wisconsin: Gay Mills, 1♀, 8 July 1953 (C. L. Fluke) [RDS]. Canada: Hull (Quebec), 1♀, 19 Aug. 1894, 1♂, 23 June 1895 [CNC]; Ontario, Ottawa, 1♀ [USNM].

Remarks: The very long ovipositor, shagreened gaster and form of the flagellomeres (Fig. 6) readily distinguish the females. Presence of a stigma in the male hind wing (Fig. 13) will separate the males from all other known North American Spathius, and is the basis for the specific name, stigmatus.

Table 1. Measurements and ratios of selected characters for females of the brachyurus species group. Top line in each instance gives range; number below is for holotype or lectotype.

	<u>brachyurus</u>	<u>brevipalpus</u>	<u>marshi</u>	<u>stigmatus</u>
n	25	3	13	13
number of flagellomeres	19-25 broken	19-20 19	20-24 22, 23	16-20 18
body length (mm)	3.0-5.3 3.3	3.3-4.3 3.3	2.8-4.0 3.5	3.3-5.1 4.4
FWL (mm)	2.3-3.4 2.4	2.2-2.7 2.2	2.2-2.7 2.6	2.4-3.1 2.9
MS/EH	0.67-0.82 0.67	0.73-1.00 0.95	0.78-1.00 1.00	0.70-0.96 0.88
TW/EH	0.76-1.04 0.76	1.00-1.30 1.26	1.00-1.18 1.17	1.04-1.23 1.08
IOD/EH	1.12-1.78 1.48	1.58-1.95 1.90	1.50-1.89 1.89	1.33-1.58 1.36
OTW/OED	0.63-0.92 0.79	0.53-0.65 0.56	0.53-0.72 0.56	0.56-0.69 0.59
OED/OOD	0.68-0.90 0.88	0.82-0.83 0.82	0.82-0.95 0.90	0.67-0.80 0.71
Pet. L/(2-3)L	1.03-1.29 1.17	1.04-1.07 1.04	1.00-1.50 1.25	0.90-1.22 1.00
ICu ₁ /R ₂	0.66-1.00 0.74	0.58-0.67 0.58	0.77-0.96 0.78	0.50-0.80 0.56
OSL/FWL	0.39-0.60 0.46	0.52-0.55 0.55	0.69-0.96 0.73	2.20-2.70 2.60

In Ashmead's (1893) key, S. stigmatus keys out exactly to S. laflammei Provancher, and indeed one specimen from CNC bears this determination label in Ashmead's handwriting.

Distribution: Paratype localities suggest a distribution covering eastern North America, although except for Texas the species has not been recorded south of North Carolina. Additional specimens add only Indiana.

Hosts: Hopkins cards in the U. S. National Museum and records of Blackman and Stage (Syracuse) indicate that S. stigmatus has been reared from hickory dead 3-4 years in association with the cerambycid Neichnea laticornis Say and the clerid Phyllobaenus dislocatus Say (from Hopk. No. 10383). Black-

man and Stage's (1924, p. 165) reference to Spathius trifasciatus Riley is probably a misidentification and instead almost surely refers to this new species, since the data on the specimens is in almost exact agreement. They conclude that one of its hosts is Magdalis olyra Herbst. (See also "Hosts" and "Remarks" under S. trifasciatus.) The paratype from Texas was reared from pecan infested by cerambycids which had previously emerged; several associated insects are listed under Hopkins No. 3861. Of two additional females in the U. S. National Museum, one was reared from Celtis (Hopk. No. 2573) and the other bears the label "parasitic on Xyloterinus politus [Scolytidae] in maple."

5. Spathius calligaster, new species

(Figs. 17, 20)

Holotype. - female, South Carolina: Georgetown, 28 Mar. 1938 (F. C. Craighead) ex. Melasis pectinicornis ? in Myrtle [USNM Type No. 70500].

Description of type female: Body length, 5.6 mm; FWL, 3.7 mm; ovipositor length, 5.5 mm.* Other measurements and ratios in Table 2.

Head: Head slightly dorsoventrally compressed (Fig. 17), the eyes slanted obliquely, creating a relatively broader lower temple area; flagellomeres 37; face transversely strigose-granular; frons transversely striate, the center area slightly rugose; vertex delicately transversely striate anteriorly, posteriorly becoming smooth in front of occipital carina; temples delicately strigose more or less parallel to occipital carina, this strongest posteriorly, becoming smooth at eye and malar space; ocellar triangle very weakly raised and delicately granular, areas between the lateral ocelli and eyes, separating vertex and frons, smooth.

Thorax: Thorax strongly dorsoventrally compressed (Fig. 17), about 3x as long as high at tegulae; lateral areas of prothorax distinct and moderately excavated, the anterior margins converging dorsally to form a distinct transverse swelling slightly in front of the anterior mesonotal margin (Fig. 17); notauli crenulate anteriorly, meeting in a broad slightly depressed rugose area; mesonotum sloping gradually to pronotum, the lobes evenly granular; scutellar furrow shallow, narrowest medially, about as wide as distance between lateral ocelli and crossed by about 7 variously developed carinae, some partially obscured; scutellum nearly flat and evenly granular on disc; mesopleural disc nearly smooth immediately above sternaulus, becoming delicately horizontally strigose to reticulate-rugose on upper portions and granular posteriorly; sternaulus moderately excavated, a gently curved furrow, deepest about midway between fore and middle coxae and with several irregular raised cross carinae which do not continue onto mesopleural disc; prepectal carina incomplete dorsally above sternaulus (Fig. 17); prepectal area smooth and somewhat reflexed posteriorly, with a few hairs and faint irregular raised rugosities; propodeum nearly horizontal; propodeal carinae mostly obscured, lateral carinae best developed; areola, costulae and basal forks completely obscured by reticulate rugosity which merges into the coarsely granular dorsal areas; basal carina faintly developed, rather long, extending to about half

* In this species the ovipositor sheaths tend to coil strongly on all dried specimens, hence the actual ovipositor length was measured.

the length of propodeum; fore tibia with 19 spines arranged in an irregular double row and with a row of 7 spines at apex; outer apical lobe of hind tibia with no spines present; hind coxae elongate, slender and coarsely granular all over, except for very faint oblique striation dorsally; outer face of hind tibiae irregularly longitudinally striate; tegulae granular medially, the outer portions smooth; subdiscoideus vein exactly interstitial; first abscissa of radius distinctly shorter than recurrens; first intercubitus with a distinct curvature (Fig. 20); mediella with 3 distinct abscissae.

Table 2. Measurements and ratios of selected characters for females of the calligaster and longipetiolatus species groups. Top line in each instance gives range; number below is for holotype or lectotype; longipetiolatus is known only from the type.

	<u>calligaster</u>	<u>longipetiolatus</u> (holotype male)	<u>elegans</u>	<u>evansi</u>
n	12	1	16	11
number of flagellomeres	27-42 37	22	30-39 31	35-48 45
body length (mm)	3.5-6.5 5.7	3.4	3.4-6.8 5.6	3.7-8.5 6.4
FWL(mm)	2.5-4.5 3.7	2.4	2.7-5.0 4.2	3.2-5.5 4.7
MS/EH	0.48-0.57 0.57	0.43	0.49-0.65 0.49	0.48-0.60 0.50
TW/EH	0.68-0.94 0.71	0.57	0.62-0.78 0.67	0.57-0.69 0.63
IOD/EH	1.13-1.35 1.20	1.14	1.05-1.28 1.05	1.02-1.14 1.08
OTW/OED	0.59-0.75 0.67	1.00	0.68-0.89 0.83	0.70-0.85 0.72
OED/OOD	0.77-1.00 0.83	0.67	0.63-0.79 0.72	0.63-0.72 0.67
Pet. L/(2-3)L	1.04-1.24 1.23	1.40	1.55-1.89 1.89	1.45-1.71 1.53
ICu ₁ /R ₂	0.83-1.00 0.91	0.96	0.81-1.33 1.08	0.88-1.12 1.05
OSL/FWL	1.28-1.71 1.48	-	1.06-1.51 1.43	1.58-2.02 2.02

Abdomen: Petiole straight, not arched basally, sculpture coarsely granular to rugose reticulate with a pair of wrinkled longitudinal carinae along most of each side above the spiracles; tergite (2-3) entirely coarsely granular-reticular except apical margin which is smooth, the sculpture strongest on basal half, this delimited by a faint transverse line at about midpoint of tergite; tergite (2-3) thickened laterally almost entire length; remaining tergites granular basally, the apical margins distad of the setae rows smooth; intensity of sculpture progressively diminishes on each succeeding tergite, becoming punctulate on penultimate tergite; epipleurites lacking obvious sculpture, at most dull shagreened.

Color: Body color more or less uniformly pale testaceous except the posterior margin of the mesonotum and scutellar carinae are dark brown and gaster with very faint darker subcuticular transverse bands dorsally and pale stramineous ventrally; antennae, tegulae and fore legs honey yellow; maxillary and labial palpi, all trochanters, basal 1/4 to 1/3 of tibiae, and fore and mid coxae cream white; hind coxae, mid and hind femora and tibiae darker, dull testaceous; mandible tips ferruginous; ovipositor sheaths pale testaceous, the tips darker, almost brown; wings banded as in Figure 20; costal vein honey yellow, other veins tan, the basal vein and media darkest; basal 1/3 of stigma pale stramineous.

Variation: Paratype females. In addition to variation indicated in Table 2, body color may be generally darker to more or less uniformly dull ferruginous; however, the basic pattern prevails, i.e., the fore and mid coxae are always much lighter than the hind coxae, and the antennae, fore legs and tegulae are usually at least slightly lighter than the predominating body color; flagellomeres, at least basal ones, often with a darker narrow apical rim; eyes gray to black, very rarely showing any iridescence in white light; prepectal carinae variously developed, almost completely obscured in the smallest female and occasionally appearing complete in larger individuals; subdiscoideous position somewhat variable, not always interstitial; gastral sculpture beyond tergite 4 varying in degree of development, usually much diminished in intensity, the apical tergites often nearly smooth; number of fore tibial spines varying from 14-22, with a row of 6 or 7 at apex.

Paratype males: In general variation in the males parallels that found in females. Additionally, males often have some tergites beyond (2-3) laterally thickened, and also the hind wings show a slight tendency towards stigma development.

Paratypes: 12♀♀, 7♂♂, same data as holotype [USNM]. Canada, Quebec: La Trappe, 3♀♀, 1♂, 20 July 1947, 27 July 1948, 12 July 1950, 3 Aug. 1943 (J. Ouellet) [Montreal, CNC, MCZ]. U.S.A., Illinois: White Heath, 2♀♀, 2 Aug. 1940 (Ross & Riegel) [INHS]. Maryland: Patuxent Wildlife Ref., 1♂ (P. M. Marsh) [USNM]. New Jersey: Metuchen, 1♂, 13 June 1964 (Porter) [Porter]; Moorestown, 1♂, 1♀, 23 June and 13 Aug. 1939 (H. & M. Townes) [Townes]. North Carolina: Tryon, 1♀, 10 May 1946 (M. Townes) [Townes]. Virginia: Plummers Id., 1♂, 1♀, 6 June 1916, reared from Carpinus caroliniana, Hopkins No. 14023 (H. S. Barber & T. E. Snyder) [USNM].

Remarks: In addition to its somewhat dorsoventrally compressed body (Fig. 17), this species may be distinguished from all other North American Spathius by the combination of the coarsely sculptured gaster, especially tergites (2-3) and 4, the thickened lateral margin of tergite (2-3) for most of its entire length, the absence of spines on the outer apical lobe of the hind tibia, the dorsal transverse swelling on the prothorax and the first abscissa of the radius distinctly shorter than the recurrent vein. In addition, the petiole is

straight and the subdiscoideus vein is usually more or less interstitial. In its characters this species resembles those of Nixon's labdacus group.

Distribution: The known range corresponds with the paratype localities which are scattered through the eastern United States and Quebec, Canada, including Illinois, Maryland, New Jersey, North Carolina, South Carolina and Virginia.

Hosts: The holotype series from Georgetown, South Carolina, was reared with the eucnemid, Melasis pectinicornis Melsh. in myrtle, according to their labels and data filed under Hopkins No. 17412e in the U. S. National Museum. No other associated insects are mentioned. The paratypes from Virginia were reared from Carpinus caroliniana in association with Leptura mutabilis Newm., Leptostylus macula Say (both Cerambycidae) and Melasis pectinicornis, according to data filed under Hopkins No. 14023 in the U. S. National Museum.

6. Spathius longipetiolatus Ashmead

(Fig. 22)

Spathius longipetiolatus Ashmead 1893, Can. Ent. 25: 70.

[Type locality: Florida: Jacksonville (Lectotype male in USNM, Type No. 52647)].

Redescription of lectotype male: Body length, 3.4 mm; FWL, 2.4 mm; other measurements and ratios in Table 2.

Head: Flagellomeres 22; face transversely strigose; frons with several polished transverse striations; vertex strongly transversely striate like frons, those of vertex separated from those of frons by a smooth transverse space about width of ocellar triangle, the striae nearly obscured medially; temples smooth and shining; ocellar triangle slightly raised, polished.

Thorax: Lateral areas of prothorax broad, deeply excavated and polished, bordered by a well defined carina and crossed by 7-8 oblique carinae; notauli shallowly crenulate anteriorly, meeting in an area of weak rugosity from which emerge 2 posterior carinae extending to posterior margin of mesonotum; mesonotum abruptly declivous, the lobes evenly granular; scutellar furrow with 3 prominent cross carinae flanked laterally by a less strong carina on each side; scutellum slightly projecting and more or less smooth, with faint sculpture laterally and posteriorly; mesopleural disc smooth and shining above sternaulus, becoming somewhat rugose dorsally; sternaulus deeply excavated, especially posteriorly, smooth, crossed by 6 or 7 carinae, the space posterior to furrow with curved striae extending to mesocoxal cavity; prepectal carina complete; prepectal area smooth with slight surface irregularity; propodeal carinae all distinct; basal carina about 1/4x as long as its forks; fore tibia with at least 12 spines arranged in a single row; outer apical lobe of hind tibia with apparently 4 spines; tegulae smooth; subdiscoideus vein nearly interstitial; recurrent vein almost 2x first abscissa of radius; first intercubitus and second abscissa of radius subequal.

Abdomen: Petiole slender and elongate, about 2/3 as long as thorax and irregularly longitudinally strigose dorsally; tergite (2-3) nearly smooth and shining, very faintly shagreened at base; remaining tergites smooth and shining, the lateral margins thickened; genitalia as in Figure 22.

Color: Body color light ferruginous, the head lighter testaceous and petiole darker, almost castaneous; antennae testaceous on basal segments, becoming gradually darker apically; legs unicolorous, honey yellow, the tibiae

not banded and the tarsi very slightly darker; maxillary and labial palpi and tegulae testaceous; propodeal spiracle testaceous, contrasting with ferruginous propodeum; wings subhyaline, the veins light yellowish-brown; stigma wholly brown, very slightly lighter basally.

Variation: Paralectotype male. Agrees with type in all apparent respects, but its poor condition makes adequate comparison impossible.

Female: Unknown.

Remarks: Since its description, no additional collections or records of this species have been made, and the two males on which this species is based remain unique among the Nearctic species. The combination of the smooth scutellum, slender elongated petiole, strong transverse striation on the vertex and deeply excavated sternauli and lateral areas of the prothorax make this a very distinctive species and I found no specimens which possessed these features among the material studied. The elongate petiole most resembles that of Spathius elegans, sp. n., but the two differ strikingly in most other features.

As was true for several of the Spathius described in his 1893 paper, Ashmead gave no formal description of S. longipetiolatus beyond the characters used in his "Table of Species". Although not specifically stated by Ashmead, there seems little doubt that he had at least two males before him, since he states a range for the length of "2.5-3.0 mm". In the U. S. National Museum collection are two males bearing three identical labels: "Jacksonville, Fla.", "Spathius longipetiolatus Ashm." in Ashmead's handwriting, and red "USNM Type No. 52647" on one and "USNM Paratype No. 52647" on the other. Both specimens were very dirty and embedded in glue; one I cleaned, extracted the genitalia, remounted, and have designated as lectotype. The other (missing the wings and abdomen) I labeled as paralectotype without attempting to clean it.

Distribution: Known only from the type locality, Jacksonville, Florida.

Host: Unknown.

7. Spathius elegans, new species

(Fig. 22)

Holotype.- female, Maryland: Plummers Id., vi-6-13, reared Acer, Hopkins No. 11338 (H. S. Barber) [USNM Type No. 70501.]

Description of type female: Body length, 5.6 mm; FWL, 4.2 mm; ovipositor sheath length, 6.0 mm. Other measurements and ratios in Table 2.

Head: Flagellomeres 31; face finely transversely strigose-granular, becoming granular at eyes; frons strongly transversely striate, this ending abruptly at level of lateral ocelli; vertex smooth and shining, no trace of any sculpture; temples mostly smooth and shining, a very faint trace of delicate vertical strigosity next to occiput, but perfectly smooth at eye and malar space; ocellar triangle weakly raised with weak central sculpture.

Thorax: Lateral areas of prothorax relatively broad and well defined anteriorly with prominent diagonal cross carinae, posteriorly becoming obscured in the irregular granular rugosity which covers most of propleura; pronotum with a well developed transverse ridge just behind the anterior margin; notauli crenulate anteriorly, converging into a broad moderately depressed rugose area; mesonotum moderately declivous, the lobes more or less evenly granular; scutellar furrow deep, with about 4 well developed cross carinae; scutellum very slightly convex and projecting, the disc granular, becoming

weakly rugose posteriorly; mesopleural disc irregularly rugose to granular; sternaulus a distinct furrow extending about $2/3$ of mesopleuron, with several irregular to almost rugose cross-carinae; prepectal carina complete, well developed; prepectal area smooth, shining, with a weak horizontal carina just above the fore coxa; propodeal carinae all visible, tending to be somewhat irregular and wrinkled; dorsal areas coarsely granular to weakly rugose; basal carina quite well developed, straight and about equal in length to its less well developed forks; areola and area petiolaris rather narrow and elongate, the sides subparallel, weakly rugose basally, the rugosity stronger apically; fore tibia with 39 spines arranged in row of 2-3 with an irregular row of 9 at apex; outer apical lobe of hind tibia with a row of 4 spines; hind basitarsus distinctly longer than second tarsomere (ratio of $32/13$) and tarsomere 3 slightly shorter than tarsomere 5; subdiscoideus not interstitial; second abscissa of radius slightly shorter than first intercubitus; mediella with 3 abscissae.

Abdomen: Petiole slender and nearly straight, about $3/4$ as long as thorax (Fig. 22), granular to weakly rugose dorsally, becoming irregularly longitudinally striate apically; tergite (2-3) with basal $3/8$ prominently longitudinally strigose-granular, abruptly delimited apically, followed by equal area of delicate scaly-reticulation grading imperceptibly into apical $1/4$ which is smooth and shining; lateral margin of tergite (2-3) thickened on about basal $3/8$; tergite 4 with faint sparse punctulation anterior to the setae row; remaining tergites apparently smooth.

Color: Head, pro- and mesothorax testaceous; propodeum and petiole honey yellow, distinctly lighter than remainder of thorax or gaster; gaster shining ferruginous except for a honey yellow transverse band on apical $1/4$ of tergite (2-3); legs more or less concolorous with head and thorax, except for stramineous trochanters, fore and mid coxae and basal $1/4$ to $1/5$ of tibiae; palpi also stramineous; antennae honey yellow basally becoming progressively darker testaceous towards apex; fore wing distinctly banded, the basal third of stigma whitish; veins testaceous to brown; eyes dark gray.

Variation: Paratype females. Considerable variation in size, color and intensity of sculpture occurs; color is most commonly dull ferruginous, but varies from testaceous to mostly piceous; however, the pattern always remains, especially having the propodeum and petiole distinctly lighter than the remainder of the thorax and gaster, even to the naked eye; the lighter transverse band on the apical margin of tergite (2-3) is usually discernible on the majority of individuals, but may occasionally be obscured, the gaster appearing unicolorous; eyes never with iridescent hue in white light; intensity and development of the striation on the frons varies greatly, smaller examples tending to have almost smooth frons; the vertex, however, is always smooth and shining; sculpture on the basal $3/8$ of tergite (2-3) is always distinctly present, but that on the next $3/8$ is variable, sometimes almost completely obscured; the rugose sculpture of the mesopleuron is also variously expressed, occasionally obscured; scutellar furrow with 3-8 variously developed cross carinae, some of which may be wrinkled and irregular medially; relative lengths of the first intercubitus and second abscissa of the radius are not reliable, about half of the individuals having the first intercubitus shorter than or equal to the second abscissa of radius; hind basitarsus is always distinctly longer than the second tarsomere and the fifth tarsomere is usually slightly longer than the third; number of fore tibial spines varies from 22-48 with a row of 7-10 at apex; outer apical lobes of hind tibiae with a row of 3-5 spines. Variation in measurements and ratios given in Table 2.

Paratype males: In general, variation tends to parallel that in females.

Smaller males are very difficult to distinguish because the useful sculpture differences tend to become obscured.

Paratypes: 6♀♀, same data as holotype [USNM]. Canada, Ontario: Pt. Pelee, 1♀, 1 July 1957 (H. & M. Townes) [Townes]; Ottawa, 1♀, 16 Aug. 1947 (W. R. M. Mason) [CNC]. Quebec: Messines, 1♀, 10 July 1947 (W. R. M. Mason) [CNC]; Wakefield, 1♀, 20 June 1946 (G. S. Walley) [CNC]; Gatineau Park, Old Chelsea, 3♀♀, 8 July 1966 (D. R. Smith) [USNM]. U.S.A., Alabama: Chambers Co., Langdale, 1♀ (H. H. Smith) [USNM]. Connecticut: Redding, 1♀, 28 July 1933 (Melander) [MCZ]. Florida: Gainesville, 1♀, 19 May 1918 (C. J. Drake) [Syracuse]. Illinois: Urbana, U. of Ill. Woods, 2♀♀, 12 July and 22 Aug. 1937 (Sarah Jones) [INHS]; Jonesboro, 1♀, 21 June 1939 (Burks & Riegel) [INHS]; Warren, 1♀, 13 June 1955 (R. L. Fischer) [MSU]. Kansas: Douglas Co., 1♀, 30 May 1951 (J. G. Rozen) [Berkeley]. Kentucky: Golden Pond, 1♀, 10 June-10 Aug. 1964 (S. G. Breeland) [Townes]. Maryland: Takoma Pk., 1♂, 2♀♀, 5 July 1942, 9 May & 10 July 1943 (G. F. Townes and H. & M. Townes) [Townes]; Bowie, 2♂♂, 24 June 1945 (H. & M. Townes) [Townes]. Massachusetts: Sharon, 1♀, 3 Aug. 1904 [MCZ]; Petersham, 1♀, 17 July [MCZ]. Michigan: Midland Co., 1♀, 7 Sept. 1944 (R. R. Dreisbach) [USNM]. New Hampshire: Mt. Madison, 1♀, 24 June 1938 (H. & M. Townes) [Townes]; White Mts., Dolly Copp, 2♀♀, 13 July 1931 (A. L. Melander) [MCZ]. New Jersey: Metuchen, Woodwild Pk., 3♀♀, 6 Sept. 1955, 15 Aug. 1956, 8 July 1955 [Porter]. New York: Bemus Pt., 5♀♀, 2♂♂, 26 June and 6, 8, 11, 22, 31 July 1937 (H. K. Townes) [Townes]; Millwood, 3♀♀, 1♂, 21 June 1936 (H. K. Townes) [Townes]; Colden, 1♀, 7 June 1908 (M. C. Van Duzee) [CAS]; Albany Co. nr. Rensselaerville, Huyck Preserve, 2♀♀, 28 June and 1 July 1967 (R. & J. Matthews) [MCZ]. North Carolina: Pisgah Mt., 1♀, 21 June 1940, 4800-5300 feet (H. & M. Townes) [Townes]; Crabtree Mds., Yancey Co., 1♀, 21 Aug. 1950, 3600 ft. (H., M. & D. Townes) [Townes]. Pennsylvania: Wilawanna, 2♀♀, 25 July 1938 (R. H. Crandall) [Arizona]. Tennessee: Green Briar Cove, Mount trail, GSMN Park, 1♀, 12 June 1946 [RDS]. Vermont: Jacksonville, Laurel Lake, 1♀, 15 July 1939 (H. D. Pratt) [Minnesota]. District of Columbia: Washington, 3♀♀, 26 & 29 Aug. 1907, 7 Sept. 1907, bred from Carpinus americanus (J. A. Hyslop) [USNM].

Remarks: This is one of the most frequently collected *Spathius* species although it has so far only rarely been reared. I have seen in excess of 200 specimens. A highly variable species, it may be readily identified by the combination of the smooth, shining vertex, rugose mesopleura, long hind basitarsus (always greater than 2x the second tarsomere) and the distinctly lighter colored propodeum and petiole. A number of strongly dorsoventrally compressed individuals of *S. elegans* were also noted; these are sometimes so greatly distorted that certain identification is difficult.

Distribution: Throughout eastern North America. In addition to the paratypes, I have seen specimens from Georgia, Iowa, Maine, Mississippi, Nebraska, Rhode Island, South Carolina, Virginia, West Virginia and Wisconsin. I also tentatively include here a single female from San Juan Island, Washington (RDS).

Hosts: No positive host associations are known. The holotype series was reared from maple under Hopkins No. 11338, but no host associations were made. Two males from Plummers Island, Maryland, in the U. S. National Museum were reared from Acer under Hopkins Nos. 10178 and 11341; another male was reared from black walnut, according to Hopkins No. 2566. The paratypes from Washington, D. C., were reared from Carpinus (blue beech) and another individual I saw was reared from hickory. A teneral male, probably

of this species, was reared from powderposted wood, probably as a parasite of the anobiid Hadrobregmus, according to Hopkins No. 34373c. Brues' (1927) record of Spathius simillimus is a misidentification and should be changed to this species, as his single female reared July 17 is in the MCZ (paratype from Petersham, Mass.).

8. Spathius evansi, new species

(Fig. 21)

Holotype. - female, Wyoming: Moran, Jackson Hole Bio. Sta., Aug. 1-14, 1961, 6750 feet elev. (H. E. Evans) [MCZ Type No. 31700].

Description of type female: Body length, 6.4 mm; FWL, 4.7 mm; ovipositor sheath length, 9.5 mm.

Head: Flagellomeres 45; face transversely strigose granular; frons strongly transversely striate, becoming delicately granular at eyes; vertex very faintly transversely strigose to scaly reticulate anteriorly becoming smooth posteriorly at occiput; temples posteriorly strigose more or less parallel to occipital carina, quickly diminishing in intensity towards eye, malar space and vertex; ocellar triangle slightly raised and appearing granular.

Thorax: Lateral areas of prothorax moderately developed, smooth, crossed by several diagonal carinae, these becoming obscured posteriorly in the granular to horizontally strigose sculpture of remainder of propleura; notauli deep and crenulate anteriorly, meeting in a broad strongly depressed rugose area, dominated by two wrinkled longitudinal carinae which end at posterior margin of mesonotum; mesonotum moderately declivous, the lobes evenly granular, the median lobe with a weak longitudinal depression medially; scutellar furrow relatively broad, wider than the space between the lateral ocelli, and crossed by 9 more or less parallel carinae of which the center one is most strongly developed; scutellum slightly raised and projecting posteriorly, the disc evenly granular; mesopleural disc coarsely granular to granular-rugose dorsally; sternaulus a relatively broad, distinct furrow about $2/3$ length of mesopleuron and crossed by about 13 more or less parallel vertical carinae; prepectal carina strongly developed, especially ventrally, but almost obscured just above sternaulus; prepectal area faintly scaly-reticulate; mesosternum evenly granular, except rugose midventral line; propodeal carinae tending to be obscured except those surrounding the area petiolaris and the lateral carinae; basal carina irregularly wrinkled, about 1.2x its forks which are also irregularly wrinkled; costulae nearly obscured by weak rugosity; dorsal areas granular; areola with weak granular rugosity over basal half, apically with 3 weak short longitudinal carinae; area petiolaris smooth, about as long as broad; fore tibia with 25 spines arranged in an irregular double row and a row of 6 spines at apex; outer apical lobe of hind tibia with 2 or 3 inconspicuous spines; hind coxae elongate and uniformly scaly-reticulate to finely granular with no evidence of oblique striations dorsally; hind tarsomere 3 about 1.4x as long as tarsomere 5; tegulae with inner halves granular, outer halves smooth; subdiscoideus vein not interstitial.

Abdomen: Petiole straight, slender and nearly as long as thorax, coarsely granular dorsally with irregular longitudinal striation apically; tergite (2-3) with prominent sculpture dorsally on basal $4/5$ as follows - basal $1/2$ longitudinally granular-strigose grading into a granular to scaly-reticulate area of less intensity, the apical $1/5$ smooth and shining; lateral margin of (2-3) thick-

ened on basal 1/2; remaining tergites apparently smooth except very weak punctulation visible laterally on tergites 5, 6, and 7 anterior to setal row; epipleurites dully shagreened.

Color: Body color more or less uniformly dull ferrugineous, except sculptured part of tergite (2-3) and basal 1/2 of tergite 4 are suffused with golden brown while the remaining gastral tergites approach castaneous; legs concolorous with body except testaceous trochanters, fore and mid coxae, and whitish-banded basal 1/6 to 1/4 of tibiae; antennae and ovipositor sheaths testaceous, both becoming brown apically; tegulae, maxillary and labial palpi testaceous; wings distinctly banded as in Figure 21; veins brown; basal 1/3 of stigma pale whitish, remainder brown.

Variation: Paratype females. Agree with holotype in most features, although body color is commonly lighter, dark testaceous, especially in individuals from eastern North America; propodeum, petiole and gaster visibly lighter than remainder of thorax in some individuals, and gaster often of one hue instead of darker apically as in holotype; paratype from New Mexico with the median mesonotal lobe suffused with golden brown; eyes usually a dull greyish, never with any iridescent hue in white light; vertex sculpture sometimes obscured, but sculpture on tergite (2-3) always developed; number of fore tibial spines varies from 25-36 with a row of from 5-9 spines at apex; outer apical lobe of hind tibia with 2-5 spines; variation in measurements and ratios given in Table 2.

Paratype males: In general, variation tends to parallel that in the females.

Paratypes: Canada, Quebec: La Trappe, 2♀♀, 10 July and 2 Aug. 1943 (J. Ouellet) [Montreal, CNC]. U. S. A., Florida: Jackson Co., Fla. Caverns St. Pk., 1♀, 23 June 1961 (H. V. Weems, Jr.) [USNM]. Iowa: Ames, 1♀, 4 Aug. 1951 (W. S. Craig) [USNM]. Maryland: Patuxent Ref., Bowie, 3♀♀, 3♂♂, 9 Aug. 1950 (R. T. Mitchell) [USNM]; Plummers I., 2♂♂, 28 May and 4 July 1911 (J. C. Crawford) [USNM]. New Jersey: Metuchen, Woodwild Park, 5♀♀, 21 Aug. 1953 (377), 10 Aug. 1953 (501), 5 Sept. 1954 (1153), 12 June 1955 (1258) (C. C. Porter) [Porter, MCZ]. New Mexico: Cimarron, 1♀, 23 Aug. 1955, 9500 ft. (D. Townes) [Townes]. New York: Bemus Pt. 1♀, 25 July 1937 (H. K. Townes) [Townes]. North Carolina: Tryon, 1♀, Hopk. U. S. 1577e, Castanea dentata (W. F. Fiske) [USNM]. Virginia: Great Falls, 1♀, 21 July 1962 (G. Steyskal) [USNM]. West Virginia: Hardy Co., Lost River St. Pk., 1♀, 2♂♂, 1-14 Aug. 1960 (K. V. Krombein) [USNM].

Remarks: This species is the largest of the North American Spathius. It may be distinguished by the combination of the long slender straight petiole, very long ovipositor (about 1.6-2.0x FWL), tergite (2-3) sculptured on about basal .75-.80, strongly granular mesopleural disc and mesosternum, and hind tarsomere 3 distinctly longer than tarsomere 5. It is named for Dr. Howard E. Evans in grateful appreciation for his interest and guidance during my Harvard years.

Distribution: Apparently widespread throughout all but the western coast of North America. In addition to the paratype localities I have seen specimens from Colorado, Ohio, Maine, Michigan, Pennsylvania and South Carolina.

Hosts: No hosts are known. The paratype from North Carolina was taken from under the bark of chestnut, Castanea dentata, according to Hopkins No. 1577e.

9. Spathius sequoiae Ashmead

(Figs. 16, 27)

Spathius sequoiae Ashmead, 1889 (1888), Proc. U. S. natn. Mus. 11: 625.

[Type locality: California: Alameda Co. (lectotype female in USNM, Type No. 2925)].

Spathius californicus Ashmead, 1893, Can. Ent. 25: 71. [Type locality:

California: Santa Cruz Mts. (holotype male in USNM, Type No. 14660)].

New synonymy.

Spathius brunneri Viereck, 1912, Proc. U. S. natn. Mus. 42: 627-628. [Type

locality: Montana: Columbia Falls (holotype female in USNM, Type No. 14730)]. New synonymy.

Females: Body length, 2.5-4.1 mm; FWL, 2.1-3.6 mm; ovipositor sheath length, 0.8-2.8 mm. Other measurements and ratios in Table 3.

Head: Flagellomeres 22-32; face transversely strigose-granular and somewhat shining; frons delicately transversely striate to almost smooth and shining; vertex virtually smooth and shining to transversely strigose; temples apparently smooth but usually with faint wrinkled sculpture posteriorly adjacent to occipital carina; ocellar triangle weakly raised, smooth to weakly strigose granular.

Thorax: Lateral areas of prothorax well developed and extending to procoxal cavities, with several irregular oblique cross carinae; remainder of propleura longitudinally strigose to weakly rugose; notauli distinct, crenulate anteriorly, meeting in a broad shallow area of weak rugosity from which often emerge two more or less parallel longitudinal carinae which extend to the posterior margin of mesoscutum; mesonotum abruptly declivous, the lobes evenly granular, the middle lobe sometimes with a faint longitudinal depression medially; scutellar furrow variable, crossed by 3-9 variously developed carinae, some of which are often wrinkled or partially obscure; scutellum slightly projecting, the disc delicately granular to scaly-reticulate and lateral faces irregularly obliquely striate; mesopleural disc highly variable, typically delicately striate, many originating as weak extensions of sternaulus cross carinae and converging posteriorly at speculum, but occasionally almost smooth above sternaulus or weakly scaly-reticulate to delicately strigose-granular; sternaulus relatively broad and well impressed, crossed by several delicate closely spaced cross carinae, the more posterior elements stronger, several curving posteriorly and continuing to mesocoxal cavities, the space following the sternaulus distinctly obliquely striate; prepectal carina complete, prepectal area smooth to irregularly surfaced, with sparse setae; propodeal carinae all sharply defined and distinct; dorsal areas granular to weakly rugose; relative lengths of basal carina and its forks variable; costulae approximately perpendicular to basal forks and directed slightly anteriorly; areola typically an elongate, almost parallel-sided trapezoid enclosing irregular raised sculpture, occasionally broadened to almost diamond-shaped; area petiolaris rectangular to sub-triangular, never longer than 2/3 of areola and usually devoid of sculpture; fore tibia with 13-33 spines arranged in double to occasionally triple irregular rows and a row of 5-8 spines at apex; outer apical lobe of hind tibia with 2-5 spines; hind coxae weakly obliquely striate dorsally; hind tarsomere 3 about equal to tarsomere 5; subdiscoideus not interstitial; first abscissa of radius shorter than recurrent vein, so that second abscissa of radius and second abscissa of cubitus converge slightly apically.

Abdomen: Petiole granular to irregularly longitudinally strigose apically

and arched at base; tergite (2-3) varying from apparently smooth or very faintly sculptured at extreme base, to a distinct area of weak scaly-reticulate, aciculate or granular sculpture on at most about basal 3/8; remaining tergites smooth, epipleurites nearly always faintly sparsely punctuate; tergite (2-3) weakly thickened laterally at base; ovipositor slightly curved, typically 0.6-0.8x FWL but rarely shorter.

Table 3. Measurements and ratios of selected characters for females of the sequoiae species group. Top line in each instance gives range; number below is for holotype or lectotype.

	<u>sequoiae</u>	<u>canadensis</u>	<u>aphenges</u>
n	27	18	7
number of flagellomeres	22-32 23	21-28 broken	20-25 23
body length (mm)	2.5-4.1 2.7	2.0-3.8 2.9	1.9-3.1 2.8
FWL (mm)	2.1-3.6 2.4	2.0-2.8 2.4	1.8-2.7 2.3
MS/EH	0.41-0.60 0.50	0.40-0.56 0.50	0.49-0.55 0.52
TW/EH	0.58-0.85 0.68	0.61-0.75 0.73	0.60-0.79 0.67
IOD/EH	1.00-1.35 1.18	1.07-1.35 1.14	1.20-1.43 1.24
OTW/OED	0.67-0.92 0.77	0.64-0.83 0.69	0.64-0.82 0.67
OED/OOD	0.71-1.00 0.87	0.75-1.09 0.81	0.81-1.00 0.81
Pet. L/(2-3)L	1.27-1.72 1.71	1.33-1.60 1.56	1.22-1.30 1.22
ICu ₁ /R ₂	0.96-1.27 1.00	0.76-1.22 1.05	0.91-1.00 0.95
OSL/FWL	0.33-0.80 0.63	0.45-0.65 0.54	0.32-0.46 0.43

Color: Body color highly variable from more or less wholly testaceous to piceous, but commonly dark ferruginous, the head very slightly lighter; typically, the apical 1/3 of the petiole and basal 1/2 of tergite (2-3) are distinctly lighter than the remainder of the gaster and thorax; legs usually lighter than body, especially in darker specimens, hind coxae and legs usually a shade

darker than the fore and mid coxae and legs, the tibiae usually distinctly lighter banded basally; antennae usually testaceous basally, becoming tan to brown apically; maxillary and labial palpi light testaceous; eyes grey, with no trace of iridescence in white light; tegulae testaceous, usually lighter than thorax; fore wings weakly infumated, at most lightly banded (Fig. 27) to subhyaline; veins and stigma tan to brown, the basal 1/3 of stigma lightened. (The wings have also been figured by Marsh, 1963 and 1965, under S. brunneri.)

Males: Essentially agree with the females in color and sculpture, paralleling the variation noted, though the sculpture, particularly of the frons, vertex and mesopleural disc tends to often be greatly reduced in intensity; however, sculpture on base of tergite (2-3) when present may cover up to the basal 1/2; also the areola of the male propodeum is often greatly reduced compared to that of the female, and the basal carina thus very long, much longer than its forks; male tarsi (Fig. 16) are proportionately distinctly shorter than those of the female, and hind tarsomere 3 is distinctly shorter than tarsomere 5; size ranges from 1.5-3.7 mm; Marsh (1965) has figured the genitalia.

Remarks: Spathius sequoiae was described by Ashmead (1889) from two females, one of which bears the label "Spathius sequoiae Ashm." in Ashmead's handwriting. I have designated this specimen as lectotype and the other becomes a paralectotype; both bear three additional labels "Alameda Co. Cal.", "Parasite on Col. larva on redwood", and the red "USNM Type No. 2925".

In addition to the types of each of the original three species, I have seen several short series of reared specimens from various species of coniferous trees in western North America, and measured about 40 selected individuals of both sexes. I have been unable to find any consistent differences by which specimens may be separated, and it appears that the chief way in which they were distinguished in the past was by sorting according to host. Spathius californicus, based on a single male, has always been an uncertain species, and was never formally described beyond the characters given by Ashmead (1893) in his "Table of Species". It was distinguished from S. sequoiae in opposite parts of his table on whether the wings appeared hyaline (californicus) or banded (sequoiae), an inadequate character. Both are from adjacent localities in California (Santa Cruz Mts. and Alameda Co.) and of opposite sex, a situation immediately suspect. Viereck (1912) described Spathius brunneri from two females reared from Pissodes in Pseudotsuga from Columbia Falls, Montana (Hopkins No. 8574). He failed to note its similarity to sequoiae, instead thinking it closest to S. unifasciatus Ashmead (= trifasciatus Riley), comparing the two in his description. Actually, they are quite different, having only superficial similarity in size and body coloration, particularly in the lightened area at the apex of the petiole and base of tergite (2-3). The very stout petiole of the type is atypical, that of the paratype being the more usual case.

Diagnosis: A highly variable species, S. sequoiae may be characterized by the weakly infumated fore wings (Fig. 28), well developed lateral areas of the prothorax, delicately transversely striate vertex, weak to almost obscure sculpture on about basal 3/8 of tergite (2-3), and the form of the sternaulus and mesopleural disc. It is most closely related to S. canadensis, from which it may usually be distinguished by the longer ovipositor (0.60-0.80x FWL versus 0.45-0.65x FWL in canadensis) and presence of more spines on the fore tibia (15-33 in irregular double and sometimes triple rows versus 11-23 in irregular single to double rows in canadensis). Qualitatively, canadensis, typically a smaller and more slender species, tends to have a more scaly reticulate mesopleural disc than sequoiae, and also may show additional weak sculpture follow-

ing the basal 3/8 sculpture on tergite (2-3). Males of the two differ additionally in relative lengths of tarsi to tibiae, *sequoiae* males having relatively shorter tarsi (Fig. 16) (hind tarsus/tibia ratio of 0.66-0.88, versus 0.84-0.96 in *canadensis* males) but small specimens may be virtually inseparable.

Indeed, until additional reared series and biological information are available, I regard this separation as tentative, but prefer to retain the two as full species rather than subsets of a polytypic species. Both *sequoiae* and *canadensis* are parasites of scolytids occurring in coniferous trees, *canadensis* being commonly reared from spruce in eastern North America and *sequoiae* from a wide variety of coniferous trees (including spruce) in western North America. A series from *Picea glauca* from Seebe, Alberta (CNC) possess some apparently intermediate characters. Another from redwood in Mill Valley, California (CAS) includes two females with very short ovipositors which would key to *aphenges* but may be distinguished by the greater petiole to tergite (2-3) ratio (1.27-1.72 versus 1.22-1.30 in *aphenges*) and the absence of sculpture beyond the basal 3/8 of tergite (2-3).

Distribution: Widespread throughout western North America, north to Alaska. I have seen material from Alaska, California, Colorado, Idaho, Montana, Oregon, New Mexico, Utah, Washington, British Columbia and Alberta.

Hosts: No hosts were previously recorded for *Spathius californicus*. *Spathius sequoiae* is recorded as a parasite of *Phloeosinus sequoiae* Hopkins and *P. punctatus* LeConte, both scolytids (Muesebeck et al., 1951, DeLeon, 1952, and Bushing, 1965). I have confirmed these records and the specimens on which they are based bear Hopkins Nos. 15815a and 18161-b. *Spathius brunneri* is recorded from *Pissodes* sp. (Curculionidae) and the scolytids *Pseudohylesinus nebulosus* (LeConte) and *Scolytus ventralis* LeConte (Viereck, 1912, Bedard, 1938, Muesebeck et al., 1951, Bushing and Bright, 1965, Bushing, 1965, Muesebeck, 1967, and Asraf and Berryman, 1969). I have also confirmed these records.

According to the material before me, *S. sequoiae* has been reared from scolytids in the following trees: *Pseudotsuga*, *Tsuga*, *Chamaecyparis*, *Larix*, *Sequoia*, *Thuja*, *Abies* and *Picea*. The majority of the records are from *Pseudotsuga*; associated insects are listed under Hopkins Nos. 8574, 10764b, 20225, 31532-F, 31713-D, 35312-E, 353560 and 39696b. Additional hosts not recorded above include the scolytids *Dendroctonus pseudotsugae* Hopkins and *Scolytus tsugae* Swaine. Host records from *Tsuga* include *Scolytus* sp., recorded under Hopkins Nos. 1849n2, 2174e5, 2174g2a and 19858. The single record from *Chamaecyparis* (Hopkins No. 33316c) lists *Phloeosinus sequoiae* and *P. punctatus* as associated insects. The records from *Sequoia* and *Thuja* are listed above as the hosts of *Spathius sequoiae*. Hopkins No. 34214B-7 records *Dendroctonus obesus* as the host in *Picea engelmanni*. According to D. F. J. Hilton (pers. comm.) the series he reared from *Picea glauca* in Alberta was associated with the following scolytids: *Carphoborus intermedius*, *Dryocoetes affaber*, *Pityophthorus murrayanae*, *Polygraphus rufipennis*, *Scolytus piceae* and *Trypodendron lineatum*. No hosts are recorded from *Larix*.

10. *Spathius canadensis* Ashmead

Spathius canadensis Ashmead, 1891, Can. Ent. 23:2. [Type locality: Canada: Ottawa (holotype female in USNM, Type No. 52649)].

Spathius claripennis Ashmead, 1893, Can. Ent. 25: 70, 72. [Type locality: West Virginia: Morgantown (lectotype male in USNM, Type No. 2148)].
New synonymy.

Spathius clavipennis [sic] Ashmead, in Hopkins, 1892, Insect Life 4: 257.
Spathius tomici Ashmead, 1893, Can. Ent. 25: 71. [Type locality: West Virginia: Morgantown (holotype female in USNM, Type No. 52648)].
New synonymy.

Females: Body length, 2.0-3.8 mm; FWL, 2.0-2.8 mm; ovipositor sheath length, 0.95-1.7 mm. Other measurements and ratios in Table 3.

Head: Flagellomeres 21-28; face transversely strigose-granular; frons varying from almost perfectly smooth to finely transversely striate; vertex smooth and shining to delicately transversely strigose; temples typically with faint irregular sculpture posteriorly adjacent to occipital carina; ocellar triangle slightly raised, smooth to faintly strigose-granular.

Thorax: Lateral areas of prothorax moderately well developed extending to precoxal cavities and with several irregular oblique cross carinae; notauli distinct, shallowly crenulate anteriorly, meeting in a slightly depressed weakly rugose area from which two weak carinae usually extend to the posterior margin of the mesoscutum; mesonotum abruptly declivous, the lobes evenly scaly-reticulate to granular; scutellar furrow variable, with as many as 8 cross carinae but often with a single well developed medial carina flanked by weaker ones; scutellar disc scaly-reticulate to weakly granular; mesopleural disc variable, either nearly smooth above sternaulus or weakly scaly-reticulate to delicately strigose granular; sternaulus highly variable, from strongly impressed and crossed by several fine closely spaced carinae, the more posterior elements apparently continuing and curving posteriorly to mesocoxal cavities, to almost obscured, scaly-reticulate, the cross carinae indistinct or irregular and none distinctly curving posteriorly to mesocoxal cavities; prepectal carina usually complete but often weak or nearly obscured immediately above sternaulus; prepectal area more or less smooth with sparse setae and sometimes with weak irregular surface rugosity; propodeal carinae typically distinct and well defined; dorsal areas granular to weakly rugose; areola usually trapezoidal, slightly longer than broad (sometimes very elongate), enclosing weak irregular sculpture; basal carina usually not longer than its forks; fore tibia with 11-24 spines arranged in irregular single to double rows and a row of 5-7 spines at apex; outer apical lobe of hind tibia with a row of 3-5 spines; hind coxae weakly obliquely striate dorsally; tibiae and tarsi usually very slender; subdiscoideus not interstitial.

Abdomen: Petiole irregularly longitudinally strigose-granular and arched at base; epipleurite of petiole variable, sometimes more than half of the petiole length; tergite (2-3) usually with distinct area of granular to scaly-reticulate sculpture on about basal $\frac{3}{8}$ to $\frac{4}{9}$, with or without an additional very weak scaly-reticulate area following a narrow unsculptured line; remaining tergites typically smooth, but sometimes with sparse punctulation anterior to the transverse row of setae; epipleurites usually very faintly punctulate; lateral margin of tergite (2-3) usually thickened weakly at base; ovipositor slightly curved, usually 0.45-0.62x FWL.

Color: Body color usually uniformly dark shining testaceous, the gaster beyond the basal half of tergite (2-3) usually distinctly darker; legs concolorous with body or slightly lighter, hind coxae and legs sometimes a shade darker than fore and middle coxae and legs, the tibiae indistinctly lighter banded at bases; eyes grey to faintly iridescent green in white light; antennae testaceous, often lighter than head at base, becoming light brown apically; ovipositor sheaths usually brown, sometimes contrasting strongly with the lighter gaster; fore wing infumation variable, usually weakly infumated to sub-hyaline, but one

series from Wood Co., Wisconsin (RDS) has several individuals with well defined fasciations; veins and stigma tan or stramineous, the basal 1/3 of stigma usually lighter.

Males: Essentially agree with the females in color and sculpture, paralleling the variation noted; size smaller, 1.6-2.5 mm, and number of flagellomeres varies from 19 to 25; body color often much darker than for females, to nearly piceous, except lighter base of gaster and legs; wings usually hyaline to sub-hyaline; sculpture on base of tergite (2-3), when present, may cover as much as 1/2 of tergite; tarsi not especially shortened, hind tarsus to tibia ratio of 0.84-0.95.

Remarks: Since 1936, *Spathius canadensis* Ashmead has become firmly entrenched in the literature and almost automatically applied to any *Spathius* reared from elm. However, this association is incorrect (see "Remarks" for *S. benefactor*). Detailed study of Ashmead's type reveals it to agree most closely with that of *S. tomici* and with females associated with the type male of *S. claripennis*. Ashmead's concept of *canadensis*, based upon a single female from an unknown host, was insufficiently stringent, for specimens bearing his *canadensis* determination labels belong to at least three different species. It is easy to appreciate how confusion could arise, for the type belongs to a difficult complex of species and bears superficial resemblance to several other species. These misplaced *canadensis* specimens were probably identified on the basis of their overall "gestalt": chiefly their relatively small size, short ovipositor and sculpture of tergite (2-3).

The female of *S. claripennis** was previously unknown; I base my associations on three short series of both sexes from spruce: one from Webster, New Hampshire (Hopkins No. 3726c), another from Cherry Mt., New Hampshire (Hopkins No. 17614c) and the third from Rensselaerville, New York (MCZ). The males from these series closely match Ashmead's type of *claripennis*, which is an unusually small individual, and the females essentially agree with the type of *S. tomici*, described in the same paper. The type of *tomici* appears superficially different due to the strongly arched petiole with its epipleurite extending over half of the petiole length, but these characters are highly variable. The type of *S. canadensis* falls readily within the range of variation exhibited by *claripennis* and *tomici*. At first glance it might appear different due to the presence of weak punctulation which it exhibits anterior to the setal rows on tergites 4-7. However, by itself punctulation is an unreliable character, for commonly it is variously expressed within series from several *Spathius* species. Furthermore, even when present it may not be readily apparent unless the gastral tergites are somewhat distended to expose the area anterior to the transverse row of setae on each.

Diagnosis: *Spathius canadensis* may be distinguished from its closest relative, *S. sequoiae*, by its generally smaller, more slender body and smaller

* *Spathius claripennis* was apparently based on two males, according to numbers on Hopkins' original manuscript for his 1892 paper. The specimen bearing the number 2463, according to Hopkins' paper, emerged on April 20, 1892, agreeing with Ashmead's statement in his description. A second individual with the same rearing information but bearing number 2463a is also listed in the original manuscript with no date of emergence given and with the name *Spathius claripennis* written in the margin. Accordingly, I designate as lectotype the specimen bearing number 2463 and the other specimen (2463a) is thus a paralectotype.

OSL/FWL ratio (0.45-0.65 versus 0.60-0.80 in sequoiae). Additional characters are given in the key; see also "Diagnosis" for S. sequoiae.

Distribution: Probably widespread throughout northern North America, south to the higher elevations of North Carolina. I have seen specimens from the following states and provinces: Alberta, British Columbia, Maine, Manitoba, Michigan, New Hampshire, New York, North Carolina, Ontario, South Dakota, Washington, West Virginia and Wisconsin.

Hosts: Spathius canadensis, as defined here, is apparently parasitic upon Scolytidae attacking the smaller branches and crown of spruce, fir, larch and pine. The following are regarded as valid host records: Polygraphus rufipennis, Dryocoetes autographus, Ips pini, Pityophthorus balsameus, Orthotomicus caelatus, Scolytus piceae and Cryphalus sp.

Unfortunately, due to the confusion surrounding the identity of S. canadensis in the past, there have been falsely recorded, under this name, at least 19 hosts representing four coleopterous families from a diverse range of trees. (For a fairly complete summary, see Bushing, 1965.) In the following paragraphs, the interested reader will find a discussion of these.

The first hosts for S. canadensis were reported by Hopkins (1892) and included three bark beetles, Phloeosinus graniger (= dentatus), Tomicus sp. and Dryocoetes americanus (= autographus), and the weevil Magdalis olyra, from red cedar, white pine, fir and hickory, respectively; the canadensis specimens correlated with these bear, according to Hopkins' original manuscript, the numbers 2932 (and 2674, 3066), 2589, 2442 and 5180, respectively. Of these, I have been able to locate only 2442, which is S. brachyurus; although unconfirmed, those from Phloeosinus would almost certainly be S. impus.

The following year, Hopkins (1893b) added the buprestid Agrilus otiosus from hickory to the list, and furnished specific identification for the Tomicus (= Ips grandicollis), but made no mention of either Dryocoetes or Magdalis. Unable to associate names with specimens, I suggest they be doubted, especially Agrilus which was probably a host of S. simillimus.

In 1899, Hopkins added the weevil Copturus (= Cylindrocopturus) longulus from pine, another record that I am unable to confirm.

Scolytus rugulosus in apple was recorded as a host of canadensis by Schedl (1932) based on a determination by A. D. Cushman. I suspect that these specimens will probably be found to be S. benefactor.

MacAloney (1930) records Pissodes strobi (Curculionidae) which seems possible, but is again unconfirmed.

In 1936, Kaston and Becker added three new hosts from elm: Hylurgopinus rufipes, Magdalis barbata and M. armicollis. I have seen their specimens and many subsequent series reared from elm, and all should be henceforth recorded as hosts for the new species, Spathius benefactor. Pechuman (1937) added Scolytus multistriatus and Saperda tridentata from elm, and Hoffman (1938) recorded Leperisinus aculeatus from ash; these should also be changed to hosts of S. benefactor.

Hetrick (1940) listed Dendroctonus frontalis from pine; this should be transferred to Spathius pallidus. Beal and Massey (1945) report canadensis from Scolytus quadrispinosus in hickory, probably erroneous, although I have been unable to locate their specimens.

In summary, of all the hosts previously listed for Spathius canadensis, none can be confirmed for this species as it is presently defined.

The only host record previously recorded for Spathius claripennis was Ashmead's original record from the scolytid Polygraphus rufipennis under bark of Abies nigra; subsequent references to this host are listed by Bushing

(1965) under the name P. poligraphus L.

The following scolytid hosts are recorded for Spathius tomici: Dryocoetes autographus from spruce (Hopkins, 1893a); Pityophthorus balsameus from balsam fir (Felt, 1906); Orthotomicus caelatus and Scolytus piceae from larch (Blackman and Stage, 1918); Phloeosinus canadensis and P. dentatus from cedar (Schedl, 1932, and Beal and Massey, 1945). Subsequent references to each are listed by Bushing (1965). Of these, I have seen only specimens of Schedl and Beal and Massey; both records should be transferred to Spathius impus. The others, except possibly Dendroctonus simplex, seem reasonable insofar as the species is currently defined.

Previously unrecorded hosts include the scolytids Cryphalus sp. (Hopkins No. 2871) and Ips pini (Say). I have reared S. canadensis in New York from white spruce in association with Polygraphus rufipennis (Kirby), Dryocoetes autographus (Ratz.) and Crypturgus atomus LeConte (det. D. E. Bright), all Scolytidae.

11. Spathius aphenges, new species

(Fig. 26)

Holotype. - female, California: El Dorado Co., xi-1963 [no collector label], ex. Pinus lambertiana with Orthotomicus latidens [USNM Type No. 70502].

Description of type female: Body length, 2.5 mm; FWL, 2.3 mm; ovipositor sheath length, 1.0 mm. Other measurements and ratios in Table 3.

Head: Flagellomeres 23; face shining almost smooth except for weak transverse rugosity; frons nearly smooth and shining with very faint transverse striation; vertex smooth and polished; temples smooth; ocellar triangle weakly raised, smooth.

Thorax: Lateral areas of prothorax well defined, relatively broad and crossed by several oblique carinae; remainder of propleura finely horizontally strigose to smooth; notauli shallowly crenulate anteriorly, meeting in a small slightly depressed area of weak rugosity; mesonotum moderately declivous, the lobes evenly granular; scutellar furrow lacking sharp well defined cross carinae, but with 3-5 irregular variously developed carinae; scutellum slightly raised, the disc evenly granular; mesopleural disc smooth and shining, becoming abruptly rugose on dorsal anterior part above prepectal area; sternaulus deeply impressed with about 7 poorly defined cross carinae, the posterior margin clearly delimited and followed by a smooth space to mesocoxal cavities; mesosternum smooth; prepectal carina complete; prepectal area covered by sparse setae, otherwise apparently smooth with faint basal irregularities; propodeal carinae sharp and well defined; dorsal areas granular to weakly rugose; basal carina about as long as its forks; costulae inserted at about right angles to basal forks; areola approximately diamond-shaped, about 1.6x as long as basal carina and enclosing weak rugosity; fore tibia with 14 spines arranged in a single row with a row of 6 spines at apex; outer apical lobe of hind tibia with a row of 5 spines; hind coxae with weak oblique striae dorsally; subdiscoideous not interstitial.

Abdomen: Petiole arched basally, dorsally coarsely granular to rugose, becoming longitudinally strigose apically; tergite (2-3) prominently granular on basal 4/9, followed by a narrow smooth area and then 2/9 scaly-reticulate area of much less intensity, the apical 1/3 smooth; lateral margin of tergite

(2-3) weakly thickened at base; ovipositor much shorter than abdomen, about 0.43x FWL.

Color: Head shining light brown weakly suffused with dirty yellow in malar area and lower clypeus; prothorax dirty testaceous; remainder of thorax and propodeum light brown, the propodeum slightly lighter; petiole and tergite (2-3) dirty testaceous, remainder of gaster slightly darker, almost a brown; ovipositor sheaths testaceous at base, becoming brown apically; antennae testaceous basally, decidedly lighter than head, becoming light tan apically; maxillary and labial palpi, tegulae, coxae and legs wholly light testaceous, distinctly lighter than body; eyes gray, not at all iridescent in white light; wings weakly infumated as in Figure 26; veins testaceous to tan, stigma light brown, the basal 1/3 lighter stramineous.

Variation: Paratype females. Body color varies from about wholly testaceous to nearly ferruginous; appendages (except ovipositor sheaths) of lighter individuals may not particularly contrast with body as in the type; eyes never iridescent; number of fore tibial spines varies from 11-17; sculpture of frons may be totally obscured in some individuals and it is never stronger than in type; vertex and temples nearly always smooth, though occasionally faint irregularity occurs; sculpture on basal part of tergite (2-3) always present, though sometimes reduced in intensity, but sculpture on middle part of tergite is often obscured or only faintly scaly-reticulate; sternaulus development somewhat variable, sometimes barely developed with no obvious cross carinae, the whole of the mesopleuron (except dorsal part) appearing smooth; fore wings of some individuals subhyaline; variation in measurements and ratios given in Table 3.

Paratype males: The two paratype males agree essentially with the females.

Paratypes: 1♀, 1♂, same data as holotype. [USNM]. U. S. A., California: Strawberry, 1♀, 22 July 1962, Flight trap, Hopkins No. 37714GGG (W. D. Bedard) [USNM]. Oregon: Ashland, 4♀♀, 1♂, 4 June 1914, reared Pinus lambertiana, Hopkins No. 10884d (P. D. Sargent) [USNM].

Remarks: The small size and very short ovipositor (less than 0.5x FWL) immediately distinguish this species and Spathius parvulus from all the other Nearctic species. The combination of the smooth, shining vertex, non-iridescent eyes and only weakly infumated fore wings (compare Figs. 26 and 30) will usually readily distinguish aphenges from parvulus. In addition, aphenges has a relatively shorter petiole (ratio of petiole length to tergite (2-3) length, 1.22-1.30 in aphenges versus 1.33-1.45 in parvulus) and a broader temple (TW/EH, 0.60-0.79 in aphenges versus 0.50-0.63 in parvulus). Occasional individuals of S. sequoiae having ovipositors less than 0.5x FWL may be distinguished by the characters discussed in the "Diagnosis" section under that species.

Distribution: Probably widespread in western North America. In addition to the paratype localities, I have seen specimens from Idaho, Washington, Alberta and British Columbia.

Hosts: The type series was reared from the scolytid Ips latidens LeConte in sugar pine, Pinus lambertiana. The paratype series from Oregon was also reared from P. lambertiana, according to Hopkins No. 10884d, and were "ex. 2 cones of 1913 crop killed by cone beetle." Godwin and Odell's (1965) reference to Spathius sp. emerging from cones infested with this beetle (Conophthorus coniperda (Schwarz)) no doubt refer to this species, although I have not seen their specimens. A specimen from Alberta is labeled as being from the scolytid Phthorophloeus puberulus (LeConte), which according to Chamberlin (1939) attacks the tops and limbs of Douglas fir, Pseudotsuga taxifolia. I have

also seen a series of Spathius aphenes reared from Scolytus abietis Blackman in grand fir, Abies grandis, from Idaho. In addition, single females were reared from Pinus contorta in British Columbia and P. ponderosa in Oregon (Hopkins No. 10074), the latter in association with several borers and the scolytid Pityophthorus sp.

12. Spathius pallidus Ashmead

(Fig. 28)

Spathius pallidus Ashmead, 1893, Can. Ent. 25: 72, 74. [Type locality: West Virginia: Morgantown. (holotype female in USNM, Type No. 2152)].

Spathius pollidus [sic] Ashmead, in Hopkins 1893a and 1893b, Bull. W. Va. agric. Exp. Stn. 31: 145 and 32: 346.

Females: Body length, 2.2-3.8 mm; FWL, 1.9-3.2 mm; ovipositor sheath length, 1.2-2.1 mm. Other measurements and ratios in Table 4.

Head: Flagellomeres 26-33; face coarsely transversely strigose-granular, ending abruptly at malar space; eyes very slightly emarginate adjacent to antennal insertions; frons transversely striate; vertex uniformly transversely strigose, becoming less strong or scaly-reticulate to nearly smooth at eyes; temples smooth along eyes, becoming moderately strigose posteriorly, more or less parallel to occipital carina; malar space rarely greater than $1/2$ EH; ocellar triangle broad, weakly raised and delicately granular to smooth.

Thorax: Lateral areas of prothorax moderately developed, losing distinctness posteriorly in the irregular strigose-granular sculpture of remainder of prothorax; notauli distinctly impressed and crenulate anteriorly, merging to a broad, slightly depressed usually moderately rugose area; mesonotum moderately declivous, robust, greatest width at least equal to greatest length, usually slightly broader than long, the lobes evenly granular; scutellar furrow crossed by 3-10 more or less evenly spaced straight carinae; scutellum broad, weakly projecting, the disc evenly granular right to the truncate posterior margin, there never being any rugosity posteriorly; mesopleural disc rarely partly smooth, but typically strigose-granular above sternaulus, this becoming much more pronounced dorsally below wings; sternaulus broad, usually well impressed, crossed by several closely spaced variously developed carinae, many of which may appear to extend onto mesopleural disc; the space posterior to the sternaulus usually with 2-6 curved striae extending from the posterior end of the sternaulus to the mesocoxal cavity; prepectal carina weak immediately above the sternaulus; prepectal area nearly smooth, with weak surface irregularity; propodeal carinae all more or less distinct, often with numerous short side branches; dorsal areas granular to weakly rugose; basal carina usually shorter than its forks; the segments of the basal forks anterior to the costulae insertions about 2-3x the posterior segments, the areola thus an elongate trapezoid enclosing an area of irregular weak reticulation; area petiolaris rectangular, about $1/3$ as long as areola and lacking distinct sculpture centrally; fore tibia with 18-25 spines arranged in an irregular double row with a row of 5-8 spines at apex; outer apical lobe of hind tibia with a row of 3-5 spines situated somewhat anteriorly; claws often with prominent pulvilli; subdiscoideus not interstitial; first intercubitus typically slightly longer than second abscissa of radius.

Abdomen: Petiole arched at base, dorsally coarsely granular to longitu-

dinally strigose; tergite (2-3) with a distinct area of granular sculpture on about basal 2/5 to 5/11, followed almost immediately by another area of less well developed granular or scaly-reticulate sculpture extending nearly to transverse row of setae, the apical margin beyond the setal row smooth; remaining tergites vary, frequently apparently smooth, but often with weak transverse bands of faint scaly-reticulation or sparse punctulation anterior to the setal rows on at least the 4th tergite; ovipositor from 0.60-0.72x FWL.

Color: Body color typically wholly tawny yellow to light brown, but varying from light honey yellow to light ferruginous, the gaster beyond the basal 2/3 of tergite (2-3) sometimes slightly darker; coxae and trochanters concolorous, usually a shade lighter than the body, from stramineous to light testaceous; femora and tibiae concolorous with body, the basal 1/3 to 1/4 of tibiae lighter banded; tarsi testaceous, the ultimate tarsomere and claws usually slightly darker than others, typically dull ferruginous; antennae testaceous to light brown, darkening gradually toward apex; ovipositor sheaths testaceous at base, becoming dark brown on about apical 1/3; eyes light gray, sometimes with a weak iridescent hue in white light; fore wing darkly infumated and distinctly banded (Fig. 28); veins light to dark brown; stigma brown, the basal 1/3 lighter, dirty yellow to stramineous.

Males: Agree with females in most respects and parallel the variation noted, except that tergite (2-3) has a larger area of well developed granular sculpture covering about basal 1/2 followed by another area of less strong sculpture as in female, and the areola is often reduced in size, sometimes to the form of a small diamond, the basal carina thus longer than its forks; also, small individuals sometimes have marked reduction in sculpture, particularly that of vertex which may appear nearly smooth.

Remarks: The holotype, USNM Type No. 2152, bears the printed label "3768 Hopk. W. Va." which is not in Hopkins' original manuscript for his 1892 paper. Nor could I find it in the Hopkins card file. It also bears Ashmead's handwritten label "Spathius pallidus Ashm." The type catalog says two specimens were included, but I have only located the one, and consider it the holotype. It is lacking the antennae and both fore wings.

Diagnosis: Spathius pallidus is best distinguished by the combination of the typically wholly tawny yellow body with the gaster at most slightly darker beyond the base of tergite (2-3), the robust mesonotum and strigose sculpture on the mesopleural disc. It most resembles S. impus and S. parvulus, sharing the narrow temples and narrow striated vertex. It may be distinguished from impus by its greater OTW/OED ratio (0.80-0.93 versus 0.60-0.83 in impus) and the presence of additional sculpture on the middle portion of tergite (2-3) which is absent in impus. S. parvulus differs in having a shorter ovipositor (typically less than half of FWL compared to 0.60-0.70 in pallidus) and a smooth mesopleural disc; also the form of the vertex sculpture differs (see Fig. 25).

Distribution: Southeastern United States north to Massachusetts. I have seen material from the District of Columbia, Georgia, Louisiana, Maryland, Massachusetts, Mississippi, North Carolina, South Carolina, Texas and Virginia.

Hosts: Four hosts are recorded, the scolytids Ips grandicollis (Eichhoff) (= Tomicus cacographus LeConte) and Dendroctonus frontalis Zimmermann, the buprestid Chrysobothris femorata (Oliv.) and the cerambycid Callidium variabilis L. A resumé of the literature references to these hosts is given in Bushing (1965). Based on the material I have seen, the latter two hosts are probably incorrect, being most likely based on misidentifications of Spathius

simillimus or S. floridanus.

Much of the material I have seen is reared under various Hopkins numbers, all from various species of Pinus. The most frequently cited host is D. frontalis (Hopkins Nos. 10099v, 46768, 46847, and 17843d1b). New host records include the scolytid Ips avulsus (Eichhoff) (Hopkins No. 3350j) and the weevils, Pissodes nemorensis Germ. (Hopkins No. 6885h) and P. approximatus Hopkins (Hopkins No. 3810d). Hettricks' (1940) reference to Spathius canadensis as parasitic on Dendroctonus frontalis (and subsequent references to this record in Bushing, 1965) should be changed to this species, as I have seen his specimens.

13. Spathius parvulus, new species

(Figs. 25, 30)

Holotype. - female, New Mexico: Vermego, Bred Sept. 11, '08, Pinus ponderosa, Hopk. U. S. 2410a (A. D. Hopkins) [USNM Type No. 70503].

Description of type female: Body length, 2.0 mm; FWL, 1.9 mm; ovipositor sheath length, 0.75 mm. Other measurements and ratios in Table 4.

Head: Flagellomeres 21; face delicately strigose-granular; frons delicately transversely striate; vertex delicately strigose, the striae curving medially and anteriorly toward ocellar triangle (Fig. 25); temples apparently smooth with extremely faint irregularity posteriorly near occiput; ocellar triangle weakly raised with delicate granular sculpture which continues weakly onto vertex.

Thorax: Lateral areas of prothorax shallow, but distinct with several oblique cross carinae on smooth background; remainder of propleura finely granular; notauli shallowly crenulate anteriorly, losing definition posteriorly except for faint irregular rugosity in area of convergence; mesonotum robust, strongly declivous, the lobes evenly granular; scutellar furrow with 4 evenly spaced carinae; scutellum weakly convex, the disc uniformly granular; mesopleural disc apparently smooth or faintly scaly-reticulate, with delicate, predominantly horizontal striae dorsally; sternaulus a broad, shallow depression with obscure traces of a few cross carinae; prepectal carina complete; prepectal area smooth, sparsely hairy with some irregular rugosity ventrally; propodeal carinae all distinct and well developed; dorsal areas wholly granular; basal carina slightly shorter than its forks; costulae approximately perpendicular to basal forks; areola and area petiolaris distinctly separated, the areola about 1.6x as long as area petiolaris and granular; area petiolaris rectangular with one carina across basal third; fore tibia with 18 spines arranged in an irregular single row with a row of 6 spines at apex; outer apical lobe of hind tibia with 3 spines; tarsomere 5 distinctly longer than tarsomere 3 on all legs; subdiscoideus not interstitial; recurrent vein distinctly longer than first abscissa of radius.

Abdomen: Petiole about as long as middle tibia and strongly arched at base; petiole sculpture granular dorsally at base becoming irregularly longitudinally strigose at apex; tergite (2-3) with prominent granular to scaly-reticulate sculpture on about basal 2/3, the remaining 1/3 smooth; sculptured portion of two distinct intensities, basal 3/5 much stronger, abruptly becoming much less intense for remainder; lateral margin of tergite (2-3) weakly thickened at base; remaining tergites smooth; ovipositor much shorter than abdomen.

Color: Body color wholly testaceous except for gaster beyond basal 2/3 of tergite (2-3) which is dull ferruginous; ovipositor sheaths brown; legs unicolorous, testaceous, the tibiae not distinctly banded at base, the claws and

ultimate tarsomeres slightly darker; antennae testaceous, gradually becoming light brown apically; palpi testaceous; eyes with a distinct bluish-green iridescent hue in white light; wings lightly infumated as in Figure 30.

Variation: Paratype females. The three paratype females show no significant variation, although the intensity of the vertex striation shows some tendency for reduction (but still discernable); number of fore tibial spines varies from 16-18. Variation in measurements and ratios given in Table 4.

Paratype males: Similar to females in all respects except that sculpture on tergite (2-3) is much stronger and of approximately uniform intensity throughout, covering about basal 3/4 of the tergite; however, vertex striation tends to be considerably reduced in intensity to almost smooth; lateral margin of most tergites thickened; junction of costella and radiella of hind wing slightly thickened.

Paratypes: 3♀♀, 3♂♂, same data as holotype.

Remarks: This species is apparently related to Spathius impus and shares with it the relatively narrow vertex and temples. It differs from it chiefly by the shorter ovipositor (typically less than 0.5x FWL versus 0.5-1.02x FWL in impus) the more extensively sculptured tergite (2-3), and the form of the vertex sculpture (Fig. 25), which also distinguishes it from the other Nearctic species. About two dozen specimens from several localities in eastern United States are tentatively included here, but may later prove to be a distinct species. These are similar to the type series, but have the face more coarsely granular, the vertex simply transversely strigose, and are generally darker colored.

Distribution: The type series is from Vermego, New Mexico. I was unable to find this locality in Hammond's New World Atlas and think it is likely a misspelling of Vermejo, north of Maxwell in Colfax County. I have also seen specimens from South Dakota and Colorado. Specimens from eastern North America tentatively placed here are from Maine, Maryland, Massachusetts, New Hampshire, New York and West Virginia.

Hosts: The type series was recorded under Hopkins No. 2410a which lists Tomicus [=Ips] sp. in ponderosa pine as the apparent host. Three specimens from Winchester, Massachusetts (N. E. For. Ins. Lab No. 12472y2) are labeled "ex. Pissodes strobi" (white pine weevil).

14. Spathius impus, new species

(Fig. 18)

Holotype.- female, Connecticut: East River, reared 31 May 1916, Hopkins No. 10762a, Juniperus virginiana (C. R. Ely) [USNM Type No. 70504].

Description of type female: Body length, 2.9 mm; FWL, 2.5 mm; ovipositor sheath length, 1.7 mm. Other measurements and ratios in Table 4.

Head: Flagellomeres 24; face transversely strigose-granular; frons weakly transversely striate; vertex transversely strigose; temples smooth adjacent to eyes, becoming weakly wrinkled strigose posteriorly; ocellar triangle weakly granular, very slightly raised.

Thorax: Lateral areas of prothorax weakly developed, shallow, smooth with a few indistinct delicate oblique cross carinae, becoming obliterated in the finely granular-strigose sculpture of remainder of prothorax; notauli distinct, shallowly crenulate anteriorly, meeting in a slightly depressed area with weak surface irregularity dominated by two elongate subparallel longitudinal carinae

which extend to the posterior margin of mesonotum; mesonotum rather abruptly declivous, the lobes evenly granular; scutellar furrow narrowest at mid-point, with apparently 5 cross carinae; scutellar disc uniformly delicately granular or scaly-reticulate; mesopleural disc delicately granular or scaly-reticulate above sternaulus, becoming irregularly longitudinally strigose dorsally beneath wings; sternaulus broad, well impressed, with 8 or 9 weak but distinct cross carinae; prepectal carina complete; prepectal area more or less smooth with weak surface irregularity; propodeal carinae all developed, but rather delicate; dorsal areas granular to weakly rugose-reticulate; basal carina a little more than half as long as its forks; costulae more or less perpendicular to forks; areola elongate, a little more than twice as long as broad, the sides

Table 4. Measurements and ratios of selected characters for females of the pallidus species group. Top line in each instance gives range; number below is for holotype or lectotype.

	<u>pallidus</u>	<u>parvulus</u>	<u>impus</u>	<u>comes</u>
n	10	13	17	10
number of flagellomeres	26-33 broken	21-29 21	20-28 24	26-37 36
body length (mm)	2.2-2.8 3.4	2.0-3.3 2.1	1.7-3.3 2.9	2.5-5.1 5.0
FWL (mm)	1.9-3.2 broken	1.8-2.8 1.9	1.5-2.9 2.5	2.3-3.9 3.9
MS/EH	0.44-0.50 0.50	0.34-0.58 0.35	0.43-0.58 0.48	0.47-0.59 0.54
TW/EH	0.54-0.71 0.69	0.50-0.63 0.55	0.50-0.63 0.56	0.63-0.78 0.69
IOD/EH	1.03-1.21 1.15	0.96-1.26 1.05	1.00-1.19 1.12	1.09-1.28 1.14
OTW/OED	0.80-0.93 0.92	0.71-0.91 0.80	0.60-0.83 0.69	0.68-0.88 0.88
OED/OOD	0.70-0.81 0.73	0.80-1.00 0.91	0.85-1.11 0.93	0.64-0.82 0.64
Pet. L/(2-3)L	1.40-1.70 1.60	1.33-1.45 1.38	1.26-1.65 1.59	1.04-1.59 1.30
ICu ₁ /R ₂	0.93-1.17 -	0.87-1.14 1.11	0.92-1.20 1.08	0.87-1.07 0.94
OSL/FWL	0.60-0.72 -	0.35-0.64 0.39	0.50-1.02 0.68	0.91-1.57 1.26

sub-parallel, enclosing an area with several weak irregular transverse carinae; fore tibia with about 15 spines arranged in irregular rows of 2, and a row of 5 or 6 spines at apex; outer apical lobe of hind tibia with apparently 3 (Fig. 18) indistinct spines situated far forward; subdiscoideus not interstitial.

Abdomen: Petiole arched at base, longitudinally strigose-granular dorsally; tergite (2-3) with a distinct area of weak granular or scaly-reticulate sculpture on about basal $3/8$, the remainder smooth; remaining tergites smooth, the sixth tergite obliquely tilted ventrally as seen from the side, giving the gaster a somewhat truncated apex in outline; ovipositor about $0.67x$ FWL.

Color: Body color wholly testaceous except gaster beyond basal half of tergite (2-3) which is abruptly darker, light brown; eyes iridescent greenish-blue in white light; ocelli dark brown; antennae testaceous at base, becoming light brown apically; legs dark testaceous, the hind femora and tibiae slightly darker than the corresponding segments of the fore and middle legs; tibiae indistinctly lighter banded on about basal $1/4$; ovipositor sheath testaceous basally, becoming darker apically; fore wing infumated with two light brown transverse bands separated by a hyaline band through the basal $1/3$ of the stigma, the apex also hyaline; veins and apical $2/3$ of stigma light brown.

Variation: Paratype females. Little variation in sculpture intensity or color occurs, except that occasionally the middle $1/3$ of tergite (2-3) may show faint sculpture traces; number of spines on the fore tibia varies from 12-26; number of scutellar furrow cross carinae varies from about 4-8; spines on the outer apical lobe of the hind tibia are sometimes inconspicuous and occasionally apparently absent. Variation in other measurements and ratios given in Table 4.

Paratype males: Essentially parallel the variation in the females, except that the tarsi are comparatively shorter, about $3/4$ as long as their respective tibiae, and the sculptured area at the base of tergite (2-3) extends usually to about the mid-point of the tergite.

Paratypes: 8♀♀, 4♂♂, same data as holotype [USNM]. North Carolina: Tryon, 3♀♀, 4♂♂ [no date], Hopkins No. 3634d (W. F. Fiske) [USNM]. South Carolina: Yorkville, 1♀, 9 July 1913, Juniperus, Hopkins No. 9194q (J. E. Smith) [USNM].

Remarks: The paratypes are all reared from red cedar (Juniperus virginiana). In addition, I tentatively include in this species two series from Rye, New Hampshire (Hopkins Nos. 3512 and 3513b) reared from northern white cedar (Chamaecyparis thyoides) which agree with the paratypes in all characters except the ovipositor length which is distinctly longer and not overlapping ($0.94-1.02x$ FWL versus $0.50-0.72x$ FWL in red cedar reared material). Also, those from Chamaecyparis average slightly more flagellomeres (25-28 versus 20-26). Also, I include four females reared from arborvitae (Thuja occidentalis) (Hopkins No. 3751), whose ovipositors are intermediate (OSL/FWL $0.67-0.83$) and two short series with ovipositors about 0.50 FWL from bald cypress (Taxodium distichum) (Hopkins Nos. 1239b and 3378d). In all other characters, measurements and ratios, this material shows no distinctive differences, and all are parasitic on Phloeosinus species infesting conifers belonging to the families Cupressaceae and Taxodiaceae. Additional reared series from Thuja, Chamaecyparis and Taxodium are needed to determine whether the differences cited are real or representative of the extremes of a continuum.

The distinguishing characters of this species are the combination of the relatively narrow vertex and temples (see Table 4); iridescent eyes; two well-developed sub-parallel longitudinal carinae where the notauli converge; the darker gaster beyond the yellowish basal half of tergite (2-3); and the presence

of but 2-3 poorly developed (often inconspicuous) spines (Fig. 18) situated well anteriorly on the outer apical lobe of the hind tibia. Spathius impus appears most closely related to S. parvulus and S. pallidus.

The name is an arbitrary combination of letters.

Distribution: Probably widespread over the range of its host trees, in eastern North America. In addition to the paratype localities, I have seen specimens from Massachusetts, Michigan, New Hampshire, New York, Virginia, West Virginia, Florida, Louisiana, and Ottawa, Canada.

Hosts: I have seen several series from red cedar whose host is recorded as either Phloeosinus sp. or P. dentatus (Say) (Scolytidae), under Hopkins Nos. 2590a, 2591a, 2723d, h, i, j and k, 2884f, 3634d, 3639b, 6136a, 6412, 6493a, 6954, and 10762a. Material from white cedar which I provisionally include in this species (see Remarks) is recorded as reared from Phloeosinus sp. or P. canadensis Swaine, under Hopkins Nos. 3512, 3513b, 3751, and 3751b. The few specimens I have from bald cypress from southern U. S. are reared from Phloeosinus sp. under Hopkins Nos. 1239b and 3378d.

Hopkins' (1892) record of Phloeosinus graniger (= dentatus) in red cedar as a host of Spathius canadensis almost certainly belongs to this species, although I was unable to locate the specimens, which according to his original manuscript are labeled with number 2932. Also, Schedl's (1932) and Beal and Massey's (1945) records of Spathius tomici parasitic on the above hosts (and subsequent references to these records listed in Bushing, 1965) should be changed also to this species, as I have seen their respective reared series.

15. Spathius comes, new species

(Fig. 31)

Holotype. - female, Wisconsin: Neopit, 7-31-39, Hopk. U. S. 32852n, Lot No. 39-18515 ex. Melanophila fulvoguttata (H. C. Secrest) [USNM Type No. 70505].

Description of type female: Body length, 5.0 mm; FWL, 3.9 mm; ovipositor sheath length, 4.9 mm. Other measurements and ratios in Table 4.

Head: Flagellomeres 36; face strongly transversely strigose; frons with strong transverse striae, whose extremities are gently curved ventrally; vertex transversely strigose of uniform intensity from ocellar triangle to occipital carina, and becoming granular laterally at eyes; temples posteriorly strigose like vertex but becoming smooth along eye margin and at malar space; ocellar triangle slightly raised and delicately transversely strigose.

Thorax: Lateral areas of prothorax weakly developed with irregular diagonal cross carinae merging posteriorly into horizontally wrinkled to granular sculpture of remainder of propleuron; pronotum with a distinct shallow pit dorsally immediately anterior to the mesonotal margin; notauli shallowly crenulate anteriorly, converging into a broad, shallowly depressed rugose area; mesonotum abruptly declivous to pronotum, the lobes evenly granular; scutellar furrow about as broad as distance between lateral ocelli, and crossed by 7 variously developed carinae which converge slightly anteriorly; scutellum broad, weakly convex, the disc evenly granular; mesopleural disc predominantly horizontally finely striate-granular dorsally to granular above sternaulus; sternaulus relatively broad and shallow, crossed by about 17 delicate carinae which fan out slightly dorsally and quickly fade into the granular sculpture, except posteriormost elements which continue and gently arch posteriorly to meso-coxal cavity; prepectal carina complete; prepectal area with surface irregu-

larity and numerous setae; basal carina of propodeum and its forks mostly obscured by strong rugosity; costulae and carinae bounding area petiolaris distinct and well developed but with numerous irregular short branches; dorsal areas coarsely granular to rugose; lateral faces of propodeum rugose; areola and area petiolaris rugose; fore tibia with 28 spines arranged in irregular rows of two and with a row of 7 spines at apex; outer apical lobe of hind tibia with a row of 3 spines situated anteriorly; hind coxae subglobular, coarsely granular with weak oblique striation medially and dorsally; subdiscoideus not interstitial; mediella with a very short third abscissa.

Abdomen: Petiole about as long as middle tibia, stout and moderately arched basally; petiole sculpture dorsally predominantly rugose, becoming irregularly longitudinally striated apically; epipleurite of petiole extending to about petiole mid-point; tergite (2-3) with basal 13/32 weakly granular to scaly-reticulate, the remainder of the tergite smooth and shining; lateral margin of tergite (2-3) thickened on about basal 1/2; tergites 4 to 8 appearing smooth and shining, but with very faint sparse punctulation anterior to setal rows revealed at high magnification under proper light, this becoming progressively stronger apically, tergites 7 and 8 quite obviously punctulate-granular; ovipositor broadly curved and nearly as long as body.

Color: Head light orange-brown, the lower face and malar area weakly suffused with dirty yellow; prothorax, mesonotum and scutellum light ferruginous; propodeum and mesopleura dark ferruginous; petiole basally dark ferruginous, apically suffused with bright orange-brown; gaster shining ferruginous, tergites each with a lighter transverse subcuticular band anterior to setal row and sternites heavily suffused with dirty yellow; trochanters, maxillary and labial palpi and fore and mid coxae stramineous; antennae, tegulae and hind coxae and remainder of fore and middle legs testaceous, except all tibiae distinctly light banded on about basal 1/4; hind femora and tibiae light ferruginous; ovipositor sheaths ferruginous to brown; fore wings infumated and distinctly banded as in Figure 31; basal third of stigma stramineous, remainder brown; costal vein testaceous, remaining veins light tan.

Variation: Paratype females. Variation in gaster color ranges from wholly ferruginous to nearly castaneous, the subcuticular bands often obscure; basal 1/2 of tergite (2-3) is often lighter, suffused with bright orange-brown; also, lower half of mesopleura (including sternaulus) may be lighter than remainder of thorax; number of fore tibial spines varies from 17 to 28 with a row of 6-8 at apex; sculpture intensity of mesopleural disc, base of tergite (2-3) and vertex is less strong on smaller specimens; propodeal carinae usually are partially obscured as in type, but if apparently distinct, never thick and prominent; scutellar furrow carinae variously developed, sometimes somewhat wrinkled and irregular; variation in measurements and ratios given in Table 4.

Paratype males: Variation tends to parallel that of females except that margin of most gastral tergites is thickened laterally.

Paratypes: 7♀♀, 2♂♂, same data as holotype except 8 emerged 22 Aug. 1939 and are labeled Hopk. No. 32852_o [USNM]. Canada, Ontario: Waubamic, 2♀♀, 1♂, 2, 6 & 7 July 1915 (H. S. Parish) [CU]. U. S. A., New Hampshire: Durham, 4♀♀, 5♂♂, [May-June 1905] Hopk. U. S. 3516c1 and 3516c2, Tsuga bred (W. F. Fiske) [USNM]; Rye, 1♀, 1♂, 1 July 1905, Hopk. U. S. 3512f, Chmcyprs thyoides bred (W. F. Fiske) [USNM]. Ohio: Mentor, 2♀♀, 1♂, 15 May 1932, reared from hemlock borer (J. S. Houser) [USNM]. Pennsylvania: Hummelstown, 2♀♀, Hopk. U. S. 15399c, ex. Melanophila fulvoguttata in Tsuga canadensis (J. N. Knull) [USNM]. Wisconsin: Sawyer Co., 2♀♀, 4 & 30 June 1955, ex. Melanophila fulvoguttata (Hussain) [RDS].

Remarks: This species superficially resembles Spathius simillimus Ashmead (see also "Remarks" under S. simillimus). It may be distinguished from simillimus by the much longer ovipositor, absence of a well developed punctulate band anterior to the transverse row of setae on tergites 4-6, and by the narrower, less strongly granular vertex. Also, S. simillimus tends to have all propodeal carinae very thick and distinct, which is never true in S. comes.

Five females in the Porter collection from Hudson, Maryland, which differ in their longer ovipositor (about 1.7x FWL), more flagellomeres (39-43) and uniformly horizontally strigose mesopleural disc are tentatively included here until additional material is available.

Distribution: Probably widespread throughout eastern North America. In addition to the paratypes, I have seen specimens from Quebec, Nova Scotia, New York, Maryland, and West Virginia.

Hosts: Most of the reared specimens before me were bred from the buprestid Melanophila fulvoguttata (Harr.) in hemlock. Exceptions are the paratypes from Rye, N. H. (Hopk. No. 3512f) labeled as reared from Chamaecyparis thyoides (white cedar) from the scolytid Phloeosinus sp. This seems possibly a labeling error, since a long series with the same labels but Hopkins Nos. 3512 and 3512b belong to S. impus sp. n. which is commonly parasitic on Phloeosinus in red and white cedar.

Hopkins (1892, 1899) records the cerambycid Chrysobothris pusilla Cast. in spruce as a host for Spathius simillimus; this should be changed to S. comes, as the specimens (nos. 2557 and 2579, see "Remarks" for simillimus) properly belong to this new species.

16. Spathius benefactor, new species

Holotype. - female, New York: Lowr. Westchester Co., Reared elm sect.

22-27 May 1934 (A. P. Jacot) (letter 8-11-34) [USNM Type No. 70506].

Description of type female: Body length, 3.4 mm; FWL, 2.6 mm; ovipositor sheath length, 2.25 mm. Other measurements and ratios in Table 6.

Head: Flagellomeres 25; face transversely strigose and somewhat shining, becoming weakly rugose at malar spaces; frons delicately transversely striate; vertex faintly transversely strigose and shining, becoming smooth at eyes; temples posteriorly faintly wrinkled, more or less parallel to occipital carina, becoming smooth at eyes and malar spaces; ocellar triangle weakly raised and delicately strigose-granular; malar space slightly less than 1/2 eye height.

Thorax: Lateral areas of prothorax distinct anteriorly and narrow, with 3 or 4 oblique cross carinae, losing definition posteriorly in the predominantly horizontally strigose sculpture of the propleura; notauli narrow and shallowly crenulate anteriorly, meeting in a moderately depressed weakly rugose area from which 2 short posterior carinae emerge which extend to the posterior margin of mesonotum; mesonotum moderately declivous, the lobes evenly granular; scutellar furrow with 4 or 5 straight cross carinae; scutellum very weakly convex, the disc evenly granular; mesopleural disc smooth and shining above sternaulus, becoming weakly strigose posteriorly and longitudinally wrinkled dorsally below wings; sternaulus moderately impressed with about 12 ill-defined cross carinae, the most posterior elements apparently continuing and curving posteriorly to mesocoxae; mesosternum smooth, shining; prepectal carina complete; prepectal area smooth with weak irregular surface rugosity and sparse short setae; propodeal carina distinct but somewhat irregular, strongest and

best defined on posterior half of propodeum posterior to the insertion of the costulae; dorsal areas granular to weakly rugose in vicinity of basal forks and costulae; basal carina delicate and irregular, shorter than its forks which are also delicate and somewhat dissected with numerous short side branches; costulae strongest and best defined at junction with basal forks, becoming dissected and losing definition laterally; areola elongate, ill-defined anteriorly and enclosing weaker, somewhat reticulate rugosity; fore tibia with 20 spines arranged in an irregular single to double row and a row of 7-8 spines at apex; outer apical lobe of hind tibia with a row of 5 or 6 spines at apex; hind coxae sub-globular, granular to weakly obliquely striate dorsally; subdiscoideus vein not interstitial.

Abdomen: Petiole strongly longitudinally strigose dorsally, becoming somewhat reticulate rugose basally; tergite (2-3) with distinct area of granular to scaly-reticulate sculpture on about basal $2/5$ followed by a very narrow smooth space and then very much weaker central scaly-reticulation ending before the transverse row of setae, the apical margin smooth; lateral margin of tergite (2-3) weakly thickened at base; remaining tergite with transverse bands of sparse punctulation anterior to the transverse row of setae on each tergite, the 7th and 8th tergite with a somewhat more strongly shagreened sculpture, especially laterally; ovipositor $0.87\times$ FWL.

Color: Body color basically shining ferrugineous, except the pronotum, the lower half of the mesopleura and apex of the petiole to about middle of tergite (2-3) lighter, suffused with rufo-testaceous; antennae testaceous, becoming darker apically; maxillary and labial palpi stramineous; coxae and trochanters light to dark testaceous, the hind coxae darkest; femora and tibiae shining dark testaceous to ferrugineous, the hind darkest, the tibiae with a distinct lighter band on about basal $1/4$; tarsi typically testaceous, the last tarsomere slightly darker; eyes light gray with an iridescent greenish hue in white light; fore wings with two broad infumated bands separated by a hyaline transverse band through the basal $1/3$ of stigma; veins tan to stramineous.

Variation: Paratype females. Distinct transverse bands of sparse punctulation on the gastral tergites occur in about half of the specimens examined, although their visibility often depends largely on whether the tergites are sufficiently distended to expose the area anterior to the setae; the middle area of tergite (2-3) after the basal sculpture is typically smooth or at most weakly scaly-reticulate as in type; the area of sculpture at the base of tergite (2-3) is always present but sometimes very weakly developed; vertex sculpture varies from apparently smooth to well developed transverse strigosity; the mesopleural disc is nearly always smooth immediately above sternaulus but sometimes scaly-reticulate; sternaulus is typically expressed as in the type but sometimes is very shallow and obscure, and rarely is sharply infolded as a deep groove; the form of the propodeal carinae is typically as in type, but the basal carina and its forks vary from sharply defined to almost completely obscured; body color varies from dark testaceous to dark ferrugineous, but is typically shining light ferrugineous with the apex of the petiole to about the middle of tergite (2-3) lighter rufo-testaceous; the lower half of the mesopleura and the pronotum may or may not be lighter than the remainder of thorax; number of fore tibial spines varies from 12-30 with a row of 5-9 spines at the apex; the outer apical lobe of the hind tibia has from 3-6 spines but typically 4 or 5; variation in other measurements and ratios is given in Table 6.

Paratype males: Essentially parallel the same sorts of variation in sculpture and color noted for the females, except that area of sculpture on base of tergite (2-3) typically covers about basal $1/2$ of tergite, the lateral margins of

at least the anterior tergites are thickened, and the areola is usually slightly smaller than on the females, with the basal carina thus often longer than its forks.

Paratypes: 5♀♀, 9♂♂, same data as holotype [USNM, CU]. Canada: Quebec: Berthierville. 9♀♀, 2♂♂, 6 Aug. 1946 (A. Robert) [Montreal, CNC]. Massachusetts: Berkshire Co., Williamstown, 7♀♀, 8♂♂, 1 July 1965 [MCZ].

Remarks: Since Kaston and Becker's (1936) paper, the name Spathius canadensis Ashmead has come to be applied almost automatically to any Spathius reared from elm. However, detailed study of Ashmead's type (a female from Ottawa, Canada) and over 45 different series of Spathius from elm (resulting largely from the emphasis on Dutch Elm Disease research beginning in the mid-1930's) has convinced me that elm-reared Spathius belong to a single, undescribed species, and that S. canadensis is actually a senior synonym for S. claripennis and S. tomici. (See additional comments under the "Remarks" section of canadensis.) The type of S. canadensis, while having many similarities to benefactor in "gestalt", differs significantly in many respects, most notably by the type's relatively short ovipositor (0.54x FWL versus 0.62-1.09x FWL for benefactor), but also in its slightly greater ratios of IOD/EW and TW/EH and smaller ratio of OTW/OED.

In addition to the characters given in the key, Spathius benefactor is distinguished by the short malar space, always less than half of eye height, the typically wrinkled basal carina, greenish iridescent eyes and the typically smooth mesopleural disc above the sternaulus. Larger individuals are superficially similar to S. laflammei, but usually the combination of fewer flagellomeres (21-32 versus 29-42), fewer spines on the outer apical lobe of hind tibia (3-6, typically 4 or 5, versus 5-8 in laflammei, typically 6 or 7) and the narrower vertex of benefactor (see Table 6) will distinguish the two.

Biology: Under the name canadensis, this species has been investigated in some detail, particularly by Kaston (1937, 1939) and Robert (1951a & b, 1961); the life stages are figured by Kaston (1937, 1939) and Robert (1961). Kaston's drawing is reproduced in Clausen (1940) and Craighead (1950). Snodgrass (1941) has figured the male genitalia.

Kaston has studied the biology of this species' parasitism of the elm bark beetle Hylurgopinus rufipes, and Robert discusses it on three species of weevils (Magdalis barbata, M. armicollis and M. inconspicua) based on large samples over a four year period. The work of both can be summarized as follows: Spathius benefactor has two, perhaps as many as four, generations per year, a complete cycle requiring 5-6 weeks; at least two generations can be reared on the same population of weevils. It overwinters in the prepupal stage, transforming to the pupa in early May, the adults eclosing in late May. The sex ratio in the Quebec populations (Robert, 1960) was weighted in favor of the males, females never comprising more than 30-40% of the populations. Kaston states that this species attacks only the ultimate and penultimate instars, usually parasitizing only 5-10% (seldom more than 25%) of the beetle population. Robert records average levels of parasitism of 7.7-15.3% over the period 1947-1950, the highest recorded level being 57.7% at one locality in 1948.

Distribution: Throughout eastern North America north of North Carolina. I have seen several hundred specimens, representing Connecticut, Illinois, Kansas, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Vermont, Virginia, Wisconsin, and Ottawa and Quebec.

Hosts: Of the hosts formerly recorded from S. canadensis (see Bushing,

1965), the following should be transferred to this species: Hylurgopinus rufipes, Scolytus multistriatus, S. rugulosus, Magdalis barbata, M. armicollis and Leperisinus aculeatus. (For the status of the others, see under "Hosts" of Spathius canadensis as herein defined.) The only additional record is Magdalis inconspicua Horn (Robert, 1960) from elm.

17. Spathius laflammei Provancher

(Fig. 23)

Spathius laflammei Provancher, 1880, *Naturliste can.* 12: 164, fig. 12. [Type locality: Unknown, probably near Quebec City, Canada (lectotype female in Laval Univ., Quebec)].

Females: Body length, 3.5-6.1 mm; FWL, 3.0-4.7 mm; ovipositor sheath length, 2.0-3.9 mm. Other measurements and ratios in Table 6.

Head: Flagellomeres 29-42; face coarsely transversely strigose; frons with strong transverse striation; vertex typically with weak transverse striation anteriorly behind ocelli, this quickly diminishing in intensity, the posterior half smooth and shining; temples nearly smooth, with weak rugosity posteriorly paralleling the occipital carina; ocellar triangle slightly raised and finely granular.

Thorax: Lateral areas of prothorax moderately developed with several oblique cross carinae, becoming obscured posteriorly in strong longitudinal strigosity of remainder of prothorax; notauli deep and crenulate anteriorly, meeting in a broad moderately depressed rugose area; mesonotum robust and abruptly declivous, the lobes evenly granular; scutellar furrow with 4-9 well developed straight cross carinae; scutellum broad, somewhat projecting, the disc granular, becoming weakly rugose at posterior margin; mesopleural disc typically smooth and shining above sternaulus (occasionally weakly scaly-reticulate), abruptly becoming longitudinally rugose dorsally and granular posteriorly; sternaulus well impressed, broad with several distinct cross carinae, the posterior elements continuing and curving posteriorly to meso-coxal cavities; prepectal carina complete; prepectal area more or less smooth; propodeal carinae often irregular or obscured in reticulate rugosity anteriorly, best defined on posterior portion of propodeum; dorsal areas coarsely granular to reticulate-rugose; basal carina obscured to irregularly wrinkled, slightly shorter than its forks which are also irregular and dissected with numerous short reticulate side branches; areola longer than broad, often poorly defined anteriorly and usually enclosing weak reticulate rugosity; fore tibia with 24-47 spines arranged in irregular row of two and occasionally three, and a row of 7-11 spines at apex; outer apical lobe of hind tibia with a row of 5-8 conspicuous spines (Fig. 23), typically 6 or 7; subdiscoideus vein not interstitial.

Abdomen: Petiole stout, reticulate rugose to longitudinally strigose dorsally; tergite (2-3) with distinct area of granular sculpture on about basal 1/3 to 2/5, the remainder of the tergite usually smooth, shining, but occasionally with faint sculpture on middle of tergite anterior to the transverse row of setae; remaining tergites each typically with a well developed transverse punctulate band anterior to the setal row, this sometimes obscured or covered by the overlapping margin of the previous tergite, the 7th tergite often shagreened dorsally; ovipositor 0.61-0.89x FWL.

Color: Body color typically ferruginous, but varying from dark testaceous to nearly piceous, the head and apex of petiole to basal half of tergite (2-3)

lighter and the gaster beyond the basal half of tergite (2-3) darker, especially on darker individuals; coxae, trochanters and tarsi light testaceous, the hind coxae darker; femora and tibiae dark testaceous, usually nearly concolorous with thorax, the hind legs slightly darker; antennae dark testaceous, becoming darker apically; eyes gray, sometimes with a greenish iridescent hue in white light; ovipositor sheaths testaceous at base, becoming dark brown apically; fore wings with two broad dark transverse bands separated by a hyaline band through the base of stigma.

Males: Essentially agree with the females but often much smaller (2.0-4.5 mm), with as few as 20 flagellomeres, and the vertex is usually completely smooth and shining; sculpture on the base of tergite (2-3) usually covers about the basal half of the tergite and lateral margins of the tergites are thickened.

Remarks: Spathius laflammei, described in 1880, has always been poorly known, and no host records are reported. Although Ashmead (1893) included S. laflammei in his key, his concept of the species was based on something other than the type, and instead his characterization of it agrees exactly with the new species, S. stigmatus (see "Remarks" under that species). Through the courtesy of Dr. René Béique of Laval University, Quebec, I have been able to examine Provancher's type and compare it with other specimens. The type is a pinned female and bears a yellow label with the printed number 563; beneath that is a handwritten label "Spathius laflammei Prov." followed by a red lectotype label by P. M. Marsh, Feb. 1965. The fore tarsi, both middle legs and the right fore wing of the lectotype are missing; the remaining wings are very dirty and folded together. (For additional notes on Provancher's type, see Gahan and Rohwer, 1918, and Shenefelt, 1968.)

I tentatively include here several very flattened individuals which at first look quite different, their profile resembling that of S. calligaster (Fig. 17). They agree with the typical S. laflammei in sharing the broad, nearly smooth vertex and temples, but differ in the thorax shape, with the mesopleural disc usually scaly-reticulate to granular, and the body size is smaller (ranging upwards from 2.8 mm), with correspondingly fewer flagellomeres and shorter wings and ovipositor. All are in the U. S. National Museum collection, reared from hickory under Hopkins Nos. 1418a, 3649f, 3653e & f, and 10938c.

Diagnosis: This is a relatively large and robust species apparently related to S. simillimus and S. floridanus, sharing the relatively broad vertex and temples. It may be distinguished from them and from the other Nearctic species by the smooth mesopleural disc immediately above the sternaulus, almost smooth vertex and temples, and the greater number of spines on the outer apical lobe of the hind tibia (Fig. 23) (6-8 spines, versus 4-6 on simillimus and 2-4 on floridanus).

Distribution: Apparently widespread through eastern North America south to North Carolina. I have seen about fifty specimens, representing Connecticut, Kansas, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, North Carolina, Rhode Island, Virginia, Wisconsin and Quebec, Canada.

Hosts: No hosts were previously recorded. I have seen several specimens reared from hickory (Carya spp.), all of which, where known, are reported as parasitic on the weevil Magdalis olyra under the following Hopkins numbers: 3262c, 3528x1b, 3605d, 3649a, 3654d and 10761y. Also I have seen a single male labeled "ex Eucrada humeralis" (Anobiidae), and a series labeled "bred from beech" (AMNH).

18. Spathius trifasciatus Riley

(Figs. 15, 29)

Spathius trifasciatus Riley 1873, Rep. Insects No. 5: 106. [Type locality: Missouri: St. Louis (C. V. Riley) (allotype male in ANSP - not USNM Type No. 2764, see Remarks)].

Spathius unifasciatus Ashmead 1893, Can. Ent. 25: 70, 72. [Teste Muesebeck and Walkley, 1951, Agriculture Monogr. 2: 170. Type locality: West Virginia: Morgantown (holotype female in USNM, Type No. 2149)].

Females: Body length, 3.0-6.5 mm; FWL, 2.3-4.4 mm; ovipositor sheath length, 2.0-4.9 mm. Other measurements and ratios in Table 5.

Head: Antennae about as long as body; flagellomeres 25-36; face transversely strigose-granular; frons transversely striate, the central portion becoming irregularly rugose in large individuals; ocellar triangle usually distinctly raised and transversely striate; vertex delicately striate anteriorly, the intensity quickly diminishing posteriorly to become smooth and shining at occipital carina; temples delicately strigose more or less parallel to occipital carina, the intensity strongest adjacent to occipital carina and diminishing anteriorly toward eye and ventrally toward malar space which is smooth.

Thorax: Prothoracic lateral areas poorly defined, shallow, weakly crenulate anteriorly, merging posteriorly into the strongly developed predominantly horizontal strigose sculpture covering remainder of propleura; notauli deep and crenulate anteriorly, converging into a strongly depressed rugose area from which usually emerge two or three distinct short carinae which reach posterior margin of mesoscutum; mesonotum broad, moderately declivous, the lobes evenly granular; scutellar furrow deep, crossed by 5-8 strong carinae; scutellum moderately convex (but usually less so than in S. brunneus), the disc evenly granular and sides strongly obliquely striate; mesopleural disc longitudinally strigose to granular in smaller individuals, dorsally the striae become progressively stronger to reticulate-rugose on the anterior-dorsal region; sternaulus depressed, bordered below by a well developed gently curved longitudinal carina extending the length of the mesopleuron from the prepectal carina to the mesocoxal cavity and with several irregular oblique cross carinae above which curve dorsally and posteriorly; prepectal carina complete, strong; prepectal area sparsely punctate with hairs to apparently smooth; propodeal carinae development variable, the carinae usually partially obscured by the reticulate-rugose sculpture which predominates; basal carina usually much shorter than its forks; areola and area petiolaris usually confluent and slightly concave, more or less dominated by reticulate-rugose sculpture; dorsal areas granular basally, becoming reticulate-rugose in region of costulae and basal forks; fore tibia with 27-38 spines arranged in irregular rows of 2 or 3 and a row of 6-9 at apex; outer apical lobe of hind tibia with a row of 6-10 spines; hind coxae granular to obliquely striate dorsally and angled basally below; tegulae mostly finely granular; subdiscoideus not interstitial, arising above middle of brachial cell; first intercubitus almost always distinctly longer than second radial abscissa.

Abdomen: Petiole dorsally longitudinally strigose at apex to reticulate-rugose basally; tergite (2-3) usually with about basal 1/3 to 1/2 delicately scaly-reticulate, the remainder smooth or with punctulation laterally anterior to setae row (occasionally punctulation extends completely across tergite as a band in very large specimens); remaining tergites with narrow transverse punctulate

to weakly granular bands anterior to the setae row, these bands variously developed, but strongest laterally, the central portions sometimes obscured and often not visible due to the overlapping margin of previous tergite; epipleurites weakly punctulate; gastral sculpture intensity seems to vary according to individual size, smaller specimens having gasters which appear nearly smooth; margin of tergite (2-3) weakly thickened at base.

Table 5. Measurements and ratios of selected characters for females of the trifasciatus species group. Top line in each instance gives range; number below brunneus is for lectotype; trifasciatus holotype lost.

	<u>trifasciatus</u>	<u>brunneus</u>
n	13	11
number of flagellomeres	25-36	31-34 broken
body length (mm)	3.0-6.5	2.9-4.9 4.5
FWL (mm)	2.3-4.4	2.7-3.8 3.6
MS/EH	0.44-0.53	0.43-0.55 0.49
TW/EH	0.64-0.95	0.69-0.81 0.74
IOD/EH	1.02-1.24	1.00-1.14 1.09
OTW/OED	0.72-1.00	0.67-0.82 0.74
OED/OOD	0.60-0.78	0.59-0.70 0.63
Pet. L/(2-3)L	1.11-1.61	1.35-1.65 1.35
ICu ₁ /R ₂	0.92-1.42	0.97-1.04 1.03
OSL/FWL	0.87-1.20	0.45-0.68 0.50

Color: Body predominantly typically dark ferrugineous to piceous, except about apical half of petiole and about basal half of tergite (2-3), which are nearly always distinctly lighter, usually fulvous, light ferrugineous or yellow; head usually somewhat lighter than thorax; thorax with propodeum darkest, sometimes (along with base of petiole) nearly black, the prothorax, prepectal areas and lower mesopleura (sternauli) usually slightly lighter than dorsal parts (very

much lighter, stramineous, in one female from Mississippi); eyes usually an iridescent bluish-green in white light; flagellomeres dull ferruginous to nearly brown; ovipositor sheaths brown, though slightly lighter basally; palpi, fore and mid coxae testaceous; hind coxae and all femora and tibiae dull ferruginous, the hind darkest; tibiae with a distinctly lighter band on about basal $1/5$; fore wing distinctly banded as in Figure 29; basal third of stigma pale whitish yellow; veins pale brown to dull ferruginous; tegulae light ferruginous to testaceous.

Males: Agree with females in most morphological features except femora are much more swollen (Fig. 15) and margin of tergite (2-3) and most subsequent tergites is thickened laterally; also, number of spines on the fore tibia is fewer, ranging from 10-24 arranged in an irregular single to double row.

Remarks: In the U. S. National Museum are four pins of supposed S. trifasciatus Riley with red "USNM type no. 2769" labels catalogued by Ashmead in 1896: 2♀, 1♂, and 3 cocoons. In actuality, the adults represent not one but three species of Spathius: S. trifasciatus (♂), S. stigmatus, sp. n. (♀), and S. floridanus Ashmead (♀). Noting this error by Ashmead, Rohwer later affixed handwritten "Not Type. Roh." labels on the two females and "Spathius trifasciatus Riley Allotype male ? Roh." to the male specimen. However, it now appears that even this male is not the true allotype.

The source of Ashmead's confusion may possibly have been the three cocoons glued to a single point with the labels "21701" and "From Scolytus caryae" in Riley's handwriting. On file in the U. S. National Museum on 3x5 cards are excerpts from notes and letters of Riley; one card headed "No. 217R Scolytus caryae Riley" states "Bred a Bracon from it - See 5th Rept. Marked 217⁰ in Box 2, also a second one 217⁰¹ in Box 2. (Both sent to Cresson Mch 20/73)." I suspect that Ashmead somehow obtained the cocoons, discovered that the number matched that in Riley's notes, and proceeded to catalogue three specimens which he thought to have emerged from these cocoons without checking them further.

However, in 1873 Cresson was at the Philadelphia Academy, and among the Spathius which Dr. P. M. Marsh recently found there was a single male S. trifasciatus labeled "Mo." and "217⁰" with a third label "Par. Scolytus caryae" in Riley's handwriting. I have no doubt that this is the true allotype male. The female which should bear the label "217⁰¹" is apparently lost; it is definitely not in the U. S. National Museum and Dr. Marsh, in a subsequent trip to Philadelphia, has specifically searched for it, at my request, without success.

Still unexplained are how Ashmead came to have the cocoons and mismatched adults and why the cocoons were not mentioned by Riley in either his notes or original description. However, since Riley's description is based chiefly on the female and his original female specimen seems to be lost, one alternative would be to select a neotype female in addition to the positively identified allotype to henceforth stand as the name bearer for the species. Since there is always the possibility that the lost type female may eventually be found, I have decided not to select a neotype, but rather have labeled a female from Topeka, Kansas (USNM), as plesiotype so that subsequent workers will know the basis for my concept of S. trifasciatus Riley.

Additional evidence that Ashmead was confused as to the identity of Riley's S. trifasciatus is the fact that he described S. unifasciatus which has proved to be synonymous (teste Muesebeck and Walkley, 1951). I have seen Ashmead's type and agree that it is a synonym of S. trifasciatus. The type pin (USNM Type No. 2149) has both a male and female, though Ashmead mentions only

the female; however, the label number 3164 agrees with the Hopkins original manuscript for his 1892 paper. Interestingly, in his table of species, Ashmead separates *S. trifasciatus* and *S. unifasciatus* in two different parts of the key and states *S. trifasciatus* to have an ovipositor twice as long as its body, which is clearly an error. Unfortunately, this is but another indication of the haste with which he often worked.

Diagnosis: *Spathius trifasciatus* may be readily distinguished from its closest relative, *S. brunneus*, by the longer ovipositor, darker body color and the strongly depressed rugose area where the notauli converge.

Distribution: I have seen well over 100 females and at least 50 males, representing the following localities: Kansas, Maryland, Mississippi, Missouri, New Jersey, New York, North Carolina, Pennsylvania, Texas, Virginia, West Virginia and the District of Columbia. These suggest that the range of *S. trifasciatus* is eastern United States, south of a line from Massachusetts to Kansas and west to Kansas and Texas, except the extreme southeast. Probably the range will be found to mirror that of its host trees, hickory (*Carya* spp.), which occur throughout the deciduous forests of the eastern U. S.

Hosts: The first and most frequently recorded host in the literature is *Scolytus quadrispinosus* Say (= *S. caryae* Riley) in hickory. Numerous authors have cited this host and a summary of these may be found in Bushing (1965). In addition, Blackman and Stage (1924, p. 165-166) list *Magdalis olyra* in hickory as a probable host, and Felt (1915, p. 29) reports it parasitic on the hemlock borer, *Melanophila fulvoguttata* Harr. In both cases, the evidence suggests that the parasite wasps were misidentified.

In the case of *Magdalis olyra*, I have already cited the agreement between Blackman's specimen labels and his comments under *S. stigmatus* sp. n. In addition, Blackman and Stage state (p. 166) that "In not a single case was it [*S. trifasciatus*] found associated with *E. quadrispinosus* although the hickory bark beetle had emerged two years previously from the material in several of these cages." I can further add that no true *S. trifasciatus* were found among the material borrowed from the Syracuse University College of Forestry collection. The fact that one of the types catalogued as *S. trifasciatus* was *S. stigmatus* (see Remarks) suggests the possible source of error.

In the case of the *Melanophila* host record, I have not seen the reared specimens in question. However, the new species, *S. comes*, is reared from *M. fulvoguttata*, and in many respects superficially resembles *S. trifasciatus*. Also, none of the *S. trifasciatus* specimens before me are reared from hemlock. Therefore, I am inclined to doubt the validity of this host record.

The only other published host record is *Scolytus rugulosus* (Ratzeburg) (Chamberlin, 1939). Since I have no specimens which confirm this record, I am inclined to question its validity as well, especially since it is an introduced species and works primarily in *Prunus*, *Pyrus* and *Crataegus*, which are not particularly closely allied to hickory.

The available evidence suggests that *S. trifasciatus* is largely restricted to bark beetles (primarily *S. quadrispinosus*) and other borers in the various species of hickory, as originally reported by Riley and by Ashmead for *S. unifasciatus*. All reared specimens I have seen are from hickory (rarely oak), many recorded with associated insects in the Hopkins' card file at the U. S. National Museum under the following numbers: 3262c, 3458c, 6850c, 9423b3, 10764-c, 10935i, 10936b, 10937b, 10938c, 10938d. In addition I have seen the *S. unifasciatus* specimens referred to by Beal and Massey (1945) (from Durham, North Carolina, no. 1573) and can confirm their identity. Their additional reference to *S. unifasciatus* parasitizing *Hylurgopinus rufipes* is to be doubted.

19. Spathius brunneus Ashmead

(Fig. 14)

Spathius brunneus Ashmead 1893, Can. Ent. 25: 72. [Type locality: West Virginia: Morgantown (A. D. Hopkins) (lectotype female in USNM, Type No. 70507)].

Spathius bruneus [sic] Dalla Torre 1898, Cat. Hym. 4: 243.

Females: Body length, 2.9-4.9 mm; FWL, 2.7-3.8 mm; ovipositor sheath length, 1.4-2.6 mm. Other measurements and ratios in Table 5.

Head: Antennae about 1.5x FWL; flagellomeres 31-34; face transversely strigose-granular; frons finely transversely striate, becoming finely granular at eyes; vertex delicately transversely striate to nearly smooth, especially posteriorly adjacent to occipital carina; temples with delicate strigosity parallel to occipital carina, becoming finely granular toward eyes and smooth at malar space; ocellar triangle faintly granular to delicately transversely striate.

Thorax: Robust, about 0.7x as high as long (Fig. 14); lateral areas of prothorax shallow, narrow and smooth with about 9-12 oblique cross carinae, these losing definition posteriorly to become obscured by the horizontally strigose granular sculpture covering remainder of propleura; notauli shallowly crenulate anteriorly converging to a slightly depressed rugose area from which emerge usually two distinct carinae reaching posterior margin of mesonotum; mesonotum moderately declivous, broad, the lobes evenly granular; scutellar furrow broad, gently arched around anterior margin of scutellum and having 6-10 well developed evenly spaced cross carinae; scutellum strongly convex (Fig. 14), the disc evenly granular and sides obliquely striate; mesopleural disc centrally usually nearly smooth, becoming progressively granular, then with delicately swirled striations at outer limits of area and dorsally longitudinally strigose; sternaulus (Fig. 14) indistinct, smooth, and lacking cross carinae, instead bordered below by a strong gently curved longitudinal carina extending the length of the mesopleuron from the prepectal carina to the meso-coxal cavity, with up to 5 shorter, variously developed carinae more or less paralleling it above; prepectal carina complete, strong; prepectal area nearly smooth, sometimes with a few irregular oblique carinae extending from the anterior margin; propodeal carinae development variable, strongest posteriorly; basal carina weakly developed, usually shorter than its forks; areola and area petiolaris confluent, granular, crossed by several irregular carinae; costulae more or less perpendicular to basal forks; dorsal areas granular basally, becoming reticulate-rugose at costulae; fore tibia with 35-47 spines arranged in irregular rows of 2 or 3, and a row of 7-8 at apex; outer apical lobe of hind tibia with a row of 6-7 spines; hind coxae basally angled below, with indistinct oblique striations or weak granular sculpture dorsally; subdiscoideus not interstitial, arising above middle of brachial cell; tegulae basally faintly granular, apically smooth.

Abdomen: Petiole dorsally uniformly longitudinally striate at apex, becoming irregularly longitudinally strigose to reticulate-rugose at base; tergite (2-3) usually with a very weakly scaly-reticulate area on about basal 5/12, followed by a narrow smooth space and then by a narrow transverse band of sparse fine punctures immediately anterior to the subapical transverse row of elongate setae, the tergite smooth posterior to the setae row; tergites 4-7 each with similar transverse narrow punctulate bands just anterior to the setae row, these bands usually mostly covered by the overlapping margin of previous ter-

gite; ultimate tergite, when visible, appearing granular apico-laterally; variation in gastral sculpture often seems correlated with specimen size, *i. e.*, larger individuals show much more strongly developed punctulate bands and basal aciculation on tergite (2-3), while on smaller individuals the sculpture is often very faint, the gastral tergites appearing smooth; margin of tergite (2-3) weakly thickened at base.

Color: Body more or less uniformly testaceous except gaster beyond basal half of tergite (2-3), which varies from dull ferruginous to castaneous; palpi stramineous to testaceous; antennae honey yellow to testaceous, the apical 10-15 flagellomeres becoming dusky brown; flagellomeres each with a very narrow darker apical band; eyes usually an iridescent bluish green in white light; mandible tips ferruginous; legs testaceous, the tibiae, especially hind tibiae, sometimes slightly darker and always distinctly lighter on about basal 1/5, appearing banded; ovipositor sheaths testaceous basally, apical half brown; fore wing distinctly banded very similarly to *S. trifasciatus* (Fig. 29); basal third of stigma and sometimes costa pale yellow, other veins usually pale brown; costula of hind wing usually pale yellow especially in area of hamuli; tegulae pale yellow to testaceous.

Males: Agree with females in color and most morphological features except femora are much more swollen and margin of tergite (2-3) and most subsequent tergites is thickened laterally; also gastral sculpture is usually reduced in intensity, the punctulate bands often completely obscured and the basal half of tergite (2-3) usually appearing smooth. Number of fore tibial spines is also reduced, ranging from about 24-30.

Remarks: As was true for several of the *Spathius* described in his 1893 paper, Ashmead gave no formal description of *S. brunneus* beyond that in his "Tables of Species". The specimen which surely represents the type bears the labels "179 Hopk. W. Va." and "*Spathius brunneus* Ashm. ♂, ♀, Ashm." in Ashmead's handwriting. A third label in S. A. Rohwer's handwriting says "Ashmead Type". Although Ashmead does not give a host record, the number 179 matches a number on Hopkins' original manuscript for his 1892 paper in which *S. brunneus* is reported parasitic on "*Scolytus muticus* (?) and *Agrilus fallax*". On the pin are two females and one male, each on a separate point. I have placed a red ink mark near the base of the point of the female having both flagella missing and here designate this female as the lectotype. The other female and male thus become paralectotypes. Since *S. brunneus* was not previously catalogued in the U. S. National Museum type collection, it has been designated USNM Type no. 70507.

Diagnosis: This species may be readily distinguished from its closest relative, *S. trifasciatus* Riley, by its lighter body color, shorter ovipositor, less strongly depressed notauli, more conical scutellum (Fig. 14), and lack of cross carinae on the sternauli.

Distribution: In addition to the type I have seen 12 females and 6 males, all in the U. S. National Museum collection. All are reared from *Celtis occidentalis* and represent three localities: Plummers Island, Maryland; Mariana, Florida; and Morgantown, West Virginia, the type locality.

Hosts: Three hosts are recorded: *Scolytus muticus* Say, *Agrilus fallax* Say and *Scolytus ventralis* LeConte. The first two species were originally reported as hosts by Hopkins (1892), and one or both repeated in Hopkins (1893a and 1893b), Dalla Torre (1898), Pierce (1908), Chamberlin (1939) and Bushing (1965). *Scolytus ventralis* is apparently a copy error introduced by Chamberlin (1939) and repeated in Bushing (1965). Chamberlin cites Bedard (1938) as his source, but Bedard referred not to *S. brunneus* but to *Spathius brunneri* Viereck, a

known parasite of Scolytus ventralis. No additional host records have been found.

Table 6. Measurements and ratios of selected characters for females of the laflammei and simillimus species groups. Top line in each instance gives range; number below is for holotype or lectotype.

	<u>laflammei</u>	<u>benefactor</u>	<u>simillimus</u>	<u>floridanus</u>
n	10	23	12	14
number of flagellomeres	29-42 broken	21-32 25	27-33 27	23-39 broken
body length (mm)	3.5-6.1 4.7	2.2-4.3 3.4	2.9-4.5 3.3	1.4-4.6 4.0
FWL (mm)	3.0-4.7 3.8	1.9-3.4 2.6	2.5-3.4 2.8	1.9-4.2 4.1
MS/EH	0.48-0.63 0.63	0.41-0.50 0.46	0.44-0.50 0.50	0.47-0.67 0.48
TW/EH	0.67-0.77 0.77	0.55-0.74 0.57	0.57-0.67 0.62	0.64-0.85 0.67
IOD/EH	1.06-1.33 1.33	0.96-1.12 1.04	1.00-1.17 1.17	1.00-1.33 1.07
OTW/OED	0.72-0.89 0.73	0.75-1.07 0.86	0.69-0.86 0.71	0.64-0.88 0.84
OED/OOD	0.58-0.78 0.73	0.71-0.88 0.78	0.61-0.73 0.70	0.56-0.78 0.59
Pet. L/(2-3)L	1.36-1.77 1.52	1.39-2.00 1.53	1.25-1.70 1.42	1.10-1.61 1.47
ICu ₁ /R ₂	0.90-1.20 1.14	0.91-1.25 1.04	0.84-1.25 1.15	0.88-1.35 1.00
OSL/FWL	0.61-0.89 0.66	0.62-1.09 0.87	0.58-0.78 0.64	0.65-1.10 0.98

20. Spathius simillimus Ashmead

Spathius simillimus Ashmead, 1893, Can. Ent. 25: 70, 73. [Type locality: West Virginia: Morgantown (lectotype female in USNM, Type No. 2150)].

Females: Body length, 2.9-4.5 mm; FWL, 2.5-3.4 mm; ovipositor sheath

length, 1.6-2.4 mm. Other measurements and ratios in Table 6.

Head: Flagellomeres 27-33; face coarsely granular; frons strongly transversely strigose medially, giving way to granular sculpture at eyes and ocelli level; vertex relatively broad, OOD distinctly greater than OED and TW, vertex prominently and completely uniformly granular with only weak indication of transverse strigosity, this extending to frons, eyes, and continuing onto temples nearly to malar space; malar space not more than half of EH; ocellar triangle granular, weakly raised.

Thorax: Lateral areas of prothorax indistinctly defined, more or less obscured posteriorly by the generally rugose to coarsely granular sculpture of remainder of prothorax; notauli strong, crenulate anteriorly, meeting in a broad slightly depressed area of strong rugosity; mesonotum abruptly declivous, the lobes uniformly granular; scutellar furrow narrowest at mid-point, broadening laterally and crossed by 6-9 variously developed, often wrinkled irregular carinae; scutellum weakly conical, the disc granular, becoming weakly rugose at posterior margin; mesopleural disc evenly granular to scaly reticulate immediately above narrow sternaulus, giving way to stronger longitudinal strigosity dorsally; mesosternum below sternaulus also evenly granular to scaly-reticulate; sternaulus a narrow moderately impressed furrow, very slightly broader posteriorly and crossed by several variously developed, usually irregular carinae which end abruptly above, never continuing posteriorly or onto mesopleural disc; prepectal carina complete; prepectal area more or less smooth with weak surface irregularity and sparse setae; propodeal carinae prominent, very thick and always well developed, especially the basal carina and its forks; dorsal areas coarsely granular to weakly rugose; basal carina usually slightly shorter than its forks; costulae typically distinctly forked almost at base, the posterior branch extending to the posterior-lateral angles which are usually slightly projecting; areola an elongate trapezoid typically somewhat concave centrally and enclosing several irregular parallel transverse carinae; fore tibia with 16-26 spines arranged in irregular single to double rows and a row of 6-8 spines at apex; outer apical lobe of hind tibia with 4-6 spines, typically 5; hind coxae coarsely granular with weak oblique striation on the inner dorsal surface; subdiscoideus not interstitial.

Abdomen: Petiole typically robust, dorsally granular to longitudinally strigose apically and arched at base; tergite (2-3) always distinctly sculptured, approximately the basal 5/11 to 1/2 strongly granular followed immediately by a less strong or sometimes obscure granular to scaly-reticulate area on about next 3/11 to transverse row of setae, the apical 3/11 beyond the setal row always smooth; remaining tergites each with a well defined distinct transverse punctulate band immediately in front of the row of setae, the apical portion beyond the setal row smooth; punctulation extends onto the epipleurites but is much weaker; tergite (2-3) weakly thickened laterally at base; ovipositor slightly curved, 0.58-0.78x FWL.

Color: Body color basically dull to dark ferruginous except that sternauli and lower half of mesopleura are often much lighter, typically testaceous and the basal half of tergite (2-3) and apical half of petiole are usually lighter, especially in darker individuals; also, the venter and the apex of the gaster tend to be lighter than the dorsum, often testaceous; eyes dark gray, with rarely any evidence of iridescence in white light; antennae testaceous, becoming darker apically; maxillary and labial palpi dark testaceous; coxae and trochanters testaceous, never as dark as body, the hind coxae usually slightly darker than the fore and mid coxae; femora and tibiae dark testaceous to ferruginous, the tibiae distinctly lighter banded on basal 1/4 to 1/3; tarsi testaceous,

the ultimate tarsomere typically distinctly darker than others; fore wings darkly infumated with a distinct lighter transverse band medially and apically like floridanus (Fig. 3).

Males: Essentially agree with females in all important respects; number of flagellomeres varies from 23-32 and the lateral margin of most gastral tergites is thickened.

Remarks: According to the USNM Type Catalog (Type No. 2150), Ashmead had a total of 27 individuals of S. simillimus before him, including representatives of both sexes. Comparing the numbers on the labels with those on Hopkins' original manuscript for his 1892 paper, those determined as simillimus include numbers 3095, 3207 and 3262, all reared from Agrilus bilineatus living in white oak, and numbers 2557 and 2579 reared from an unknown host in Abies nigra and a buprestid larva in an unstated host. However, in his description, Ashmead does not note the latter hosts, stating simply, "Bred May 18 and 25, 1892, from Agrilus bilineatus living in White Oak stump." Also, the dates given agree only with numbers 3207 and 3262, respectively. Of four pins bearing these numbers (with a total of 12 specimens), only one also has a handwritten Ashmead label "Spathius simillimus Ashm." (No. 3262).

This background is important in order that the name simillimus may be properly and positively associated, since the 7 specimens on 4 pins labeled with numbers 2579 and 2557 belong not to simillimus, but to the new species, Spathius comes. I base my decision as to which should be called simillimus primarily upon Ashmead's statement of only the one host and the presence of his determination label on but one pin as noted above, since his description, with one exception, could apply equally well to either species. The exception is his statement "ovipositor as long or very little shorter than the body." This would apply only to comes which has a distinctly longer ovipositor (OSL/FWL 0.91-1.57) and not to simillimus as I define it (OSL/FWL 0.58-0.78). However, on the basis of the above evidence I choose to ignore this discrepancy and have selected as lectotype one of two females on one of the pins bearing number 3207, and have designated it by a red ink mark at the base of the point. All of the other specimens labeled with numbers 3207, 3095 and 3262 are thus labelled as paralectotypes.

Aldrich (1921) gives a figure of Spathius simillimus. A specimen of this species in the USNM bearing Hopkins No. 11254a has a label saying "type of drawing" and may be assumed to be the specimen on which the drawing was based.

Diagnosis: The presence of distinct transverse punctulate bands on all gastral tergites anterior to the setal row will usually distinguish this species from most other North American forms. The very well developed sculpture on the vertex and temples is also diagnostic, occurring in about equal development only on S. floridanus which has the gaster nearly smooth. The form of the sternaulus and mesopleuron is also distinctive, the carinae of the sternaulus rarely distinctly extending onto the uniformly granular to scaly-reticulate mesopleural disc or curving posteriorly to the mesocoxal cavity as in floridanus, comes or pallidus which may sometimes be confused with it.

Distribution: Probably widespread in eastern North America north of Virginia. However, as in the case of S. brunneus, I have seen only reared material, consisting of five series in all, and representing Maine, Massachusetts, Virginia, West Virginia and New Brunswick, Canada. In addition, Pennsylvania is listed (Muesebeck et al., 1951), Felt (1905) reports it from New York, and Chittenden (1897) notes its abundance in the District of Columbia. The reported occurrence of this species in Mississippi and Wisconsin

(Muesebeck, 1967) is possibly erroneous, as I have not seen material to support it.

Hosts: Recorded hosts that I have been able to confirm are the buprestids *Agrilus bilineatus* (Weber) and *A. anxius* Gory. The former was first recorded by Hopkins (1892) from white oak and has been repeated by the following: Ashmead (1893), Hopkins (1893b, 1899), Chittenden (1897), Dalla Torre (1898), Felt (1905), Viereck (1910), Muesebeck (1928, in Leonard), Doane et al. (1936), and Muesebeck and Walkley (1951). *Agrilus anxius* in birch was first reported as a host by Nash et al. (1951) and repeated in Muesebeck and Walkley (1951) and Barter (1957). Balch and Prebble's (1940) reference to *Spathius* sp. refers to this species, as I have seen their specimens (CNC).

Hopkins (1892, 1899) records two additional species as hosts: *Chrysobothris pusilla* Cast. (Cerambycidae) in spruce and the weevil *Cryptorhynchus ferratus* Say in sassafras. These are regarded as erroneous. The former is no doubt a record for the new species, *S. comes* (Hopkins manuscript numbers 2557 and 2559). The latter I am unable to substantiate or relate to any specimens I have seen.

Specimens of *S. simillimus* which I have seen bear Hopkins numbers 1717a, 11254 and 11847b. The first was reared from an unrecorded host in chestnut, the second from *Agrilus bilineatus* in chestnut and the last from the cerambycid *Callidium aereum* Newman in white oak, a new host record. Thus *Spathius simillimus* seems comparatively specific in its host preferences, attacking buprestid or cerambycid larvae in deciduous trees, especially birch and white oak.

21. *Spathius floridanus* Ashmead

(Figs. 1-3, 24)

Spathius floridanus Ashmead, 1893, Can. Ent. 25: 71. [Type locality: Florida: Jacksonville (holotype female in USNM, Type No. 52646)].

Females: Body length, 2.2-6.8 mm; FWL, 1.9-4.2 mm; ovipositor sheath length, 1.3-4.6 mm. Other measurements and ratios in Table 6.

Head (Figs. 1 and 2): Flagellomeres 23-39, face coarsely transversely strigose-granular; frons strongly transversely striate to rugose-granular, with at least the granular sculpture always extending to eyes; vertex relatively broad, OOD distinctly greater than OED (Fig. 24), and prominently and completely granular to transverse strigose-granular, extending undiminished to eyes, frons, and onto entire temple nearly to malar space; ocellar triangle weakly raised, granular.

Thorax: Lateral areas of prothorax variously defined, usually becoming obscured posteriorly in the longitudinal granular strigosity of remainder of propleura; pronotum dorsally broad with several fine slightly oblique transverse striations usually visible anterior to where the lateral areas converge; notauli deep, crenulate anteriorly meeting in a moderately depressed area of strong rugosity extending to the posterior margin of the mesonotum; mesonotum abruptly declivous, the lobes uniformly granular; scutellar furrow relatively broad with irregular variously developed cross carinae, these rarely simple and distinct but with various transverse connections and rugosity at least partially obscuring them; scutellum broad, moderately convex, the disc evenly granular, becoming weakly rugose at posterior margin; mesopleural disc variable, usually scaly-reticulate to nearly smooth anteriorly above sternau-

lus, this giving way to irregular weak more or less longitudinal rugosities immediately above posterior portion of sternaulus, with stronger longitudinal granular strigosity occurring more dorsally beneath the wings; sternaulus variously developed, from a very weak granular longitudinal impression to occasionally a sharply infolded steep-sided groove, but typically moderately impressed and crossed by several poorly developed, irregular carinae some of which may appear to extend weakly onto mesopleural disc or curve posteriorly towards mesocoxal cavities; mesosternum scaly-reticulate adjacent to sternaulus, to nearly smooth; prepectal carina complete; prepectal area more or less smooth with weak surface irregularity and sparse setae; propodeal carinae distinct, and sharply defined; dorsal areas granular to rugose; basal carina typically shorter than its forks, resulting in a relatively broad and elongate areola which typically encloses several weaker reticulate cross carinae; costulae well defined, angled somewhat anteriorly; area petiolaris small but bounded by very thick and prominent carinae laterally; fore tibia with 13-25 spines arranged in an irregular single to double row and a row of 5-9 at the apex; outer apical lobe of hind tibia with 2-4 spines, typically 3 situated somewhat anteriorly; subdiscoideus not interstitial.

Abdomen: Petiole moderately stout, arched at base, with granular irregular longitudinal strigosity dorsally; tergite (2-3) variable in degree of sculpture developed, from virtually smooth and shining with perhaps very faint traces of scaly-reticulate sculpture to distinct area of granular to scaly-reticulate sculpture on basal $3/8$ to $1/2$, rarely with any sculpture present beyond the basal half; remaining tergites typically smooth but larger individuals sometimes with weak indications of punctulate or faint scaly-reticulate transverse bands anterior to the setal row on some tergites; epipleurites usually very faintly punctulate; lateral margin of tergite (2-3) weakly thickened at base; ovipositor varies from 0.65-1.11x FWL.

Color: Body color typically light ferrugineous, but considerable variation exists from basically testaceous to dark ferrugineous, the gaster varying from entirely shining honey yellow to entirely dark shining ferrugineous or with the basal $1/2$ to $2/3$ of tergite (2-3) lighter than remainder of gaster or occasionally the gaster with two to four subcuticular narrow transverse ferrugineous bands; also the propodeum and petiole may be distinctly lighter than the gaster and remainder of thorax, or the propodeum, petiole and part or all of the gaster may be lighter than the remainder of the thorax; legs usually more or less concolorous with body or slightly lighter, especially the trochanters and tarsi; tibiae distinctly lighter banded on about basal $1/4$ - $1/3$; ultimate tarsomere usually at least slightly darker than preceding tarsomeres; antennae testaceous to light ferrugineous at base, gradually darkening apically; ovipositor sheaths testaceous basally, becoming darker brown apically; eyes typically gray, rarely with a faint iridescent hue in white light; fore wing (Fig. 3) distinctly banded and darkly infumated, veins and stigma (except lighter basal $1/3$) brown.

Males: Essentially parallel the variation in the females in sculpture and color, although smaller males often have the intensity of the sculpture somewhat reduced on the head and mesopleura; however, the most notable difference is in the amount and intensity of sculpture on tergite (2-3), which in males tends to regularly cover more than the basal $1/2$, often extending to the transverse setal row or over about $3/4$ of the tergite; also gaster color beyond the basal $2/3$ of tergite (2-3) is frequently much darker, to nearly piceous.

Remarks: This robust species, based on a single female, was never formally described beyond the characters given by Ashmead (1893) in his "Table of Species", and has heretofore been of uncertain status. In part, this was

due to its having been confused with S. trifasciatus Riley (see Remarks section under that species) and in part because the holotype is a large specimen and in some respects atypical for the species. In addition to the locality label, the holotype has a label "Spathius floridanus Ashm." in Ashmead's handwriting and the red "USNM Type No. 52646" label.

Diagnosis: This species is most closely related to Spathius simillimus, from which it may be most readily distinguished by the absence of well developed transverse punctulate bands anterior to the row of setae on each of the gastral tergites. In addition, the more rugose scutellar furrow, the usual presence of more or less longitudinal irregularity on the mesopleural disc immediately above the sternaulus, at least posteriorly (compared to the uniformly granular or scaly-reticulate mesopleural disc of simillimus) and the presence of fewer spines on the outer apical lobe of the hind tibia (typically 3, versus 5 in simillimus) will assist in distinguishing the two.

Distribution: Throughout eastern North America, from Florida to Ontario and Quebec, Canada, and west to Texas, Kansas and Minnesota. The over 300 specimens which I have seen represent nearly every state in this region.

Biology: Spathius floridanus appears to differ from the majority of the known Spathius species in that several individuals are usually reared from a single host larva. I reared four individuals from a cluster of cocoons in a cerambycid burrow under oak bark; a similar cluster of 9 cocoons is pinned with Hopkins No. 1460c, and another cluster of 7 cocoons is pinned with Hopkins No. 9909b'. Comments on the cards in the Hopkins file often state "ex mass of parasite cocoons in larval mines." In each of the above three cases, the reared adults include both sexes, suggesting that this is probably a case of multiple oviposition.

Hosts: The only host previously recorded is the buprestid Chrysobothris femorata (Oliv.) (Brimley, 1942; Muesebeck and Walkley, 1951). However, in the U. S. National Museum are long series of Spathius floridanus from several hardwoods, reared under numerous Hopkins numbers which often list hosts and associated borers. These may be summarized as follows: from oak (Quercus spp.) (Hopkins Nos. 1460c, 1421c, 3016c, 3730e, 11861k and 12858a), hosts include Chrysobothris femorata and the cerambycid Xylotrechus colonus F.; from hickory (Hicoria spp.) (Hopkins Nos. 1489f, 3447c, 3636e, 3651d and 10975c1), hosts include Chrysobothris sp. and the weevil Magdalis olyra Hbst., with several additional associated borers listed under No. 3636e; from chestnut (Castanea dentata) (Hopkins Nos. 10277b & c, 10701a-k, 11352a1, and 11353), hosts include C. femorata and X. colonus; for black walnut (Juglans nigra) (Hopkins No. 3640a-j), hosts are not specified but several associated cerambycids and buprestids are listed; for wild cherry (Prunus sp.) (Hopkins No. 10737i), parasitic on Chrysobothris sp.; for bald cypress (Taxodium distichum) (Hopkins Nos. 1732c and 1640e), host is unknown. Several additional Hopkins numbers are represented, but not listed here as they give no host tree or insect data.

SPECIES INQUIRENDA

Spathius honestor Say, 1828, Contrib. Maclur. Lyc. Phila. 1: 78.

The holotype specimen of this species is no longer extant, and the original description is inadequate to associate it, hence this species cannot be placed. Ashmead (1893) apparently did not know it, as he omitted it from his key. No hosts are recorded for this species.

SUMMARY

The braconid genus Spathius, ectoparasitic upon wood-boring beetle larvae, is revised for North America. Keys to both sexes and complete descriptions for the 21 recognized species are provided. Lectotypes are designated for the following species: brachyurus Ashm., brunneus Ashm., claripennis Ashm., longipetiolatus Ashm., sequoiae Ashm. and simillimus Ashm. New synonymies are: S. dignus Muesebeck and Walkley under S. brachyurus Ashm.; S. californicus Ashm. and S. brunneri Viereck under S. sequoiae Ashm.; and S. claripennis Ashm. and S. tomici Ashm. under S. canadensis Ashm. Newly described Spathius species include: aphenges, benefactor, brevipalpus, calligaster, comes, elegans, evansi, impus, marshi, parvulus and stigmatus.

A revised list of all verified previous and new host records includes representatives from six coleopterous families in both deciduous and coniferous trees; analysis indicates that specificity tends to be more to host habitat than to host taxon. Evidence for multiple oviposition in a single host is reported for two species, S. brachyurus and S. floridanus.

Evolutionary trends in the genus are discussed, and aspects of the biology reviewed, with particular reference to the Nearctic forms. Possible phyletic relationships are considered and the status of the four described spathiine fossils is clarified.

The long association of the name Spathius canadensis with parasites reared from elm bark borers is shown to be erroneous; rather, the status of S. canadensis is redefined to be a species which typically attacks scolytids in various coniferous trees. Most elm-reared specimens will belong to the new species, S. benefactor.

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*Abbreviations of periodicals follow World List of Scientific Periodicals, fourth edition, 1963.

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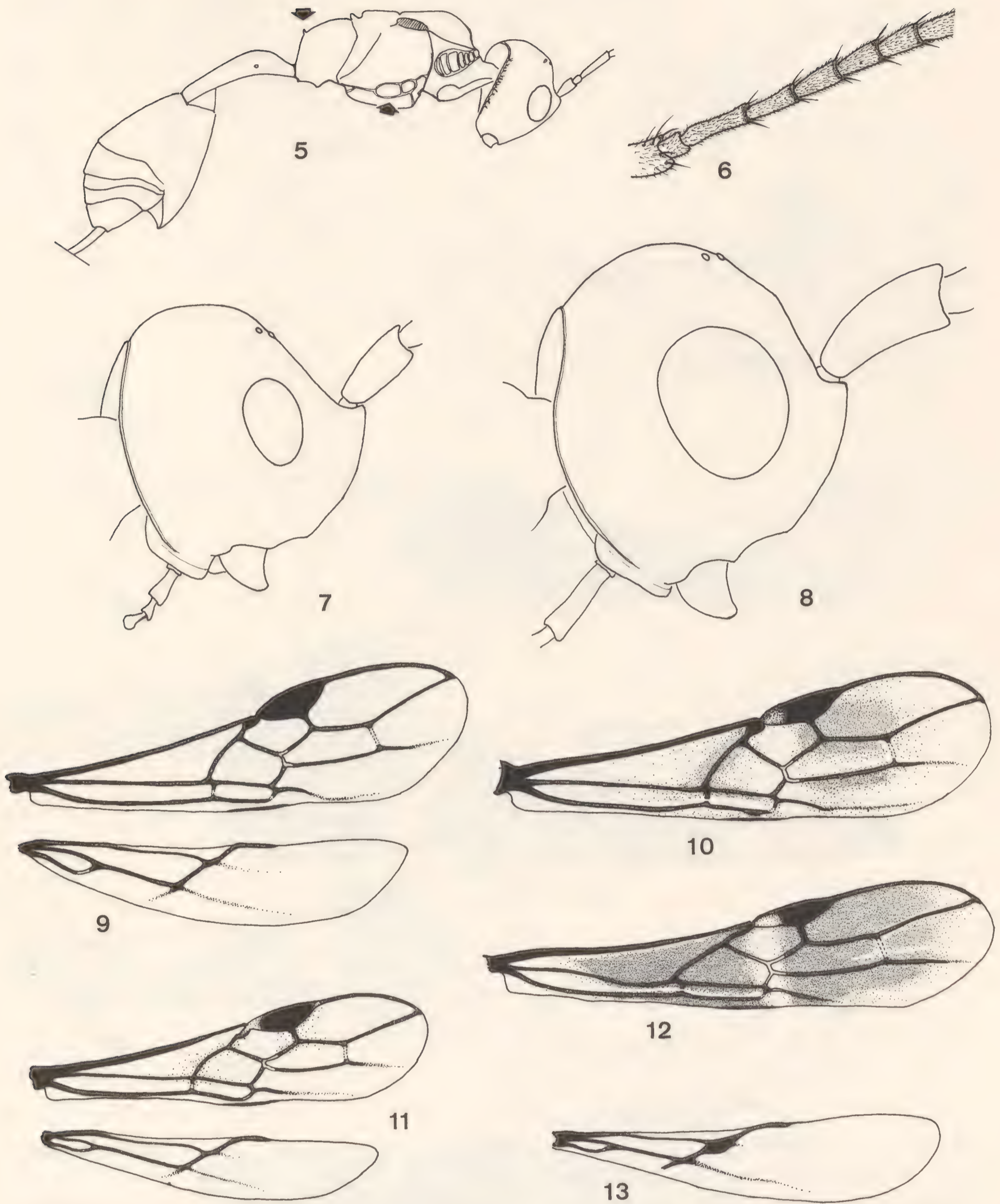


Figure 5. *Spathius marshi*, sp. n., lateral view of ♀; arrow above points to projecting carina separating areola and area petiolaris; other arrow points to sternaulus.
 Figure 6. Portion of antenna of *Spathius stigmatus*, sp. n., showing basal flagellomeres, pedicel and apical part of scape.
 Figure 7 and 8. Heads of *Spathius brevipalpus*, sp. n. and *S. brachyurus* Ashmead, respectively, lateral view, drawn at same magnification.
 Figures 9 - 13. Wings of *Spathius*, all drawn at same magnification: 9. *S. marshi*, sp. n., ♀; 10. *S. brachyurus* Ashmead, ♀; 11. *S. brevipalpus*, sp. n., ♀; 12. *S. stigmatus*, sp. n., ♀; 13. *S. stigmatus*, sp. n., ♂ hind wing.

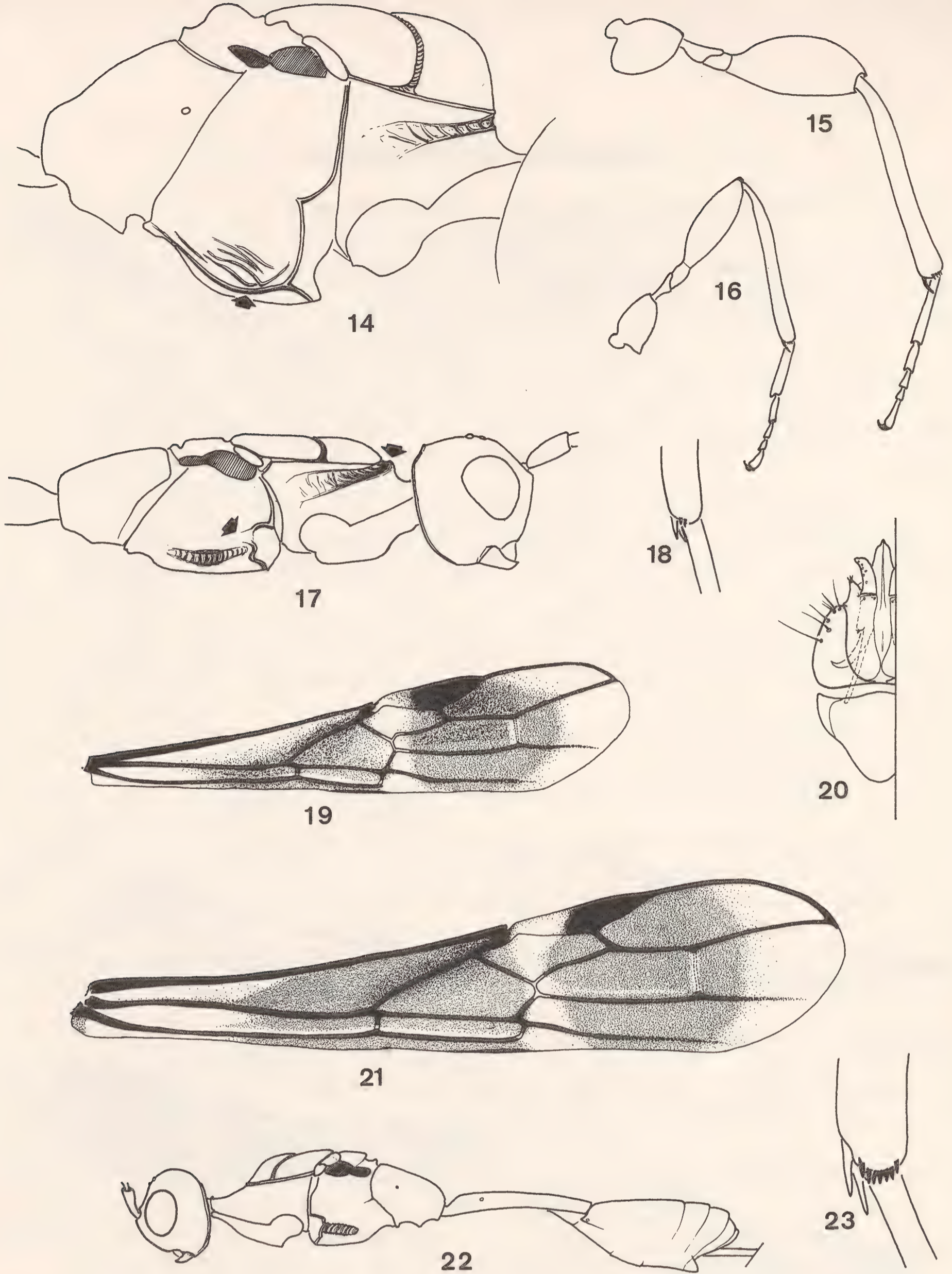


Figure 14. Thorax of Spathius brunneus Ashmead, lateral view; arrow points to longitudinal carina below sternaulus.

Figures 15 and 16. Hind legs of males of Spathius trifasciatus Riley and S. sequoiae Ashmead, respectively.

Figure 17. Head and thorax of Spathius calligaster, sp. n., lateral view, ♀; arrow above points to transverse swelling of prothorax, other arrow to incomplete prepectal carina.

Figure 18. Outer apical lobe of hind tibia of Spathius impus, sp. n.

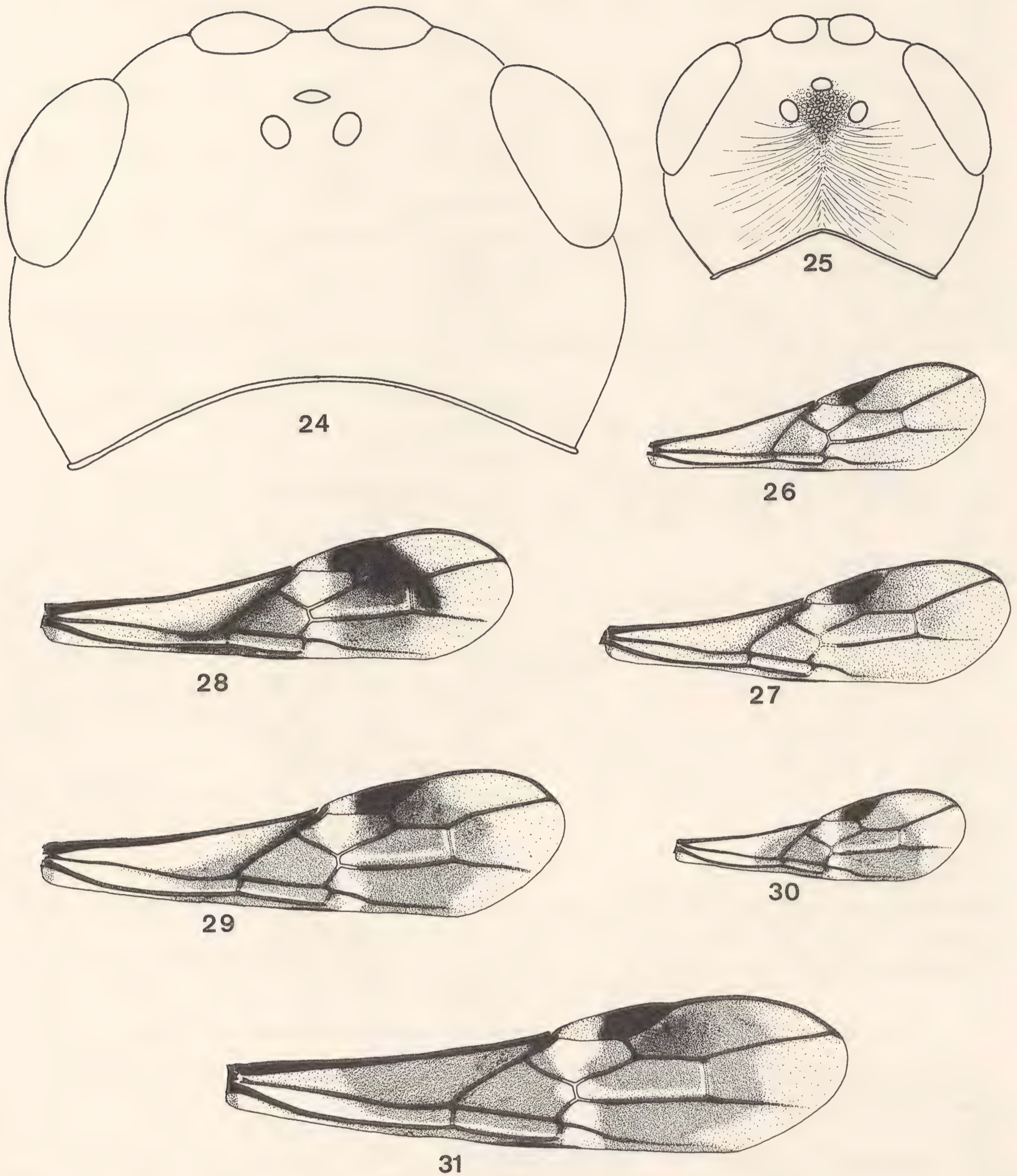
Figure 19. Fore wing of Spathius calligaster, sp. n., ♀.

Figure 20. Male genitalia of Spathius longipetiolatus Ashmead.

Figure 21. Fore wing of Spathius evansi, sp. n., ♀.

Figure 22. Spathius elegans, sp. n., lateral view of ♀.

Figure 23. Outer apical lobe of hind tibia of Spathius laflammei Provancher.



Figures 24 and 25. Heads of Spathius floridanus Ashmead and S. parvulus, sp. n., respectively; dorsal views at same magnification.

Figures 26 - 31. Fore wings of female Spathius, all drawn at same magnification:
 26. S. aphenges, sp. n.; 27. S. sequoiae Ashmead; 28. S. pallidus Ashmead;
 29. S. trifasciatus Riley; 30. S. parvulus, sp. n.; 31. S. comes, sp. n.

An asterisk indicates a synonym, misspelling, or nomen nudum.

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